

OVERCOMING LAND USE BARRIERS To SOLAR ACCESS:

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Planning Recommendations For Local Communities

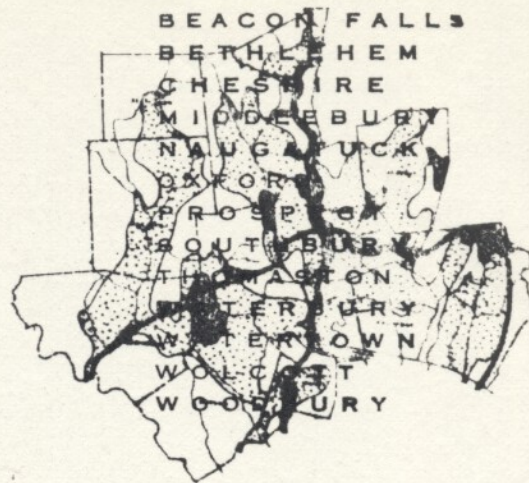
**CENTRAL NAUGATUCK VALLEY
REGIONAL PLANNING AGENCY**

FEBRUARY — 1980

THE REGION WITH A PLAN FOR THE FUTURE

CENTRAL NAUGATUCK VALLEY REGIONAL PLANNING AGENCY

KATHERINE CAMPBELL, CHAIRMAN
DUNCAN GRAHAM, EXECUTIVE DIRECTOR



March 3, 1980

Dear Citizens of the Region:

On behalf of the Agency I am pleased to transmit this report on Overcoming Land Use Barriers to Solar Access: Solar Planning Recommendations for Local Communities. This report speaks to the specific land use problems that are emerging in Connecticut with the advent of the solar age. It will undoubtedly become a basic text for all land use planners interested in the regulation and promotion of solar energy systems.

The Agency expects to continue assisting all of the Region's municipalities in their efforts to adopt "Solar Conscious" land use regulations. As we have seen from the experience of numerous cities in California, local efforts to encourage solar energy can help to reduce our dependence on costly non-renewable energy resources.

We would like to thank Arnold Wallenstein at the Northeast Solar Energy Center for his valuable suggestions and ongoing support for this project. Furthermore, Gerard Ridzon at the Northeast Solar Energy Center, Martin Jaffe at the American Planning Association, James Lash with the Enviroland Company, William Morrill, a consulting attorney for NESEC, Joel Gordes, Clerk to the Connecticut State Legislature's Energy Committee, William Duesing from the Energy Extension Service, Richard Pfurr, the Cheshire Town Planner and Vincent McDermott, with Flaherty and Giavara (formerly the Woodbury Town Planner) provided many valuable suggestions which have been incorporated into this final report. We are also grateful to those Agency Representatives who took the time to review the report prior to its release to the public.

The Agency could not have completed this study without the financial support of the Northeast Solar Energy Center and the support of the Energy Division of the Office of Policy and Management.

Sincerely yours,

Katherine Campbell
Chairman

TITLE: Overcoming Land Use Barriers to Solar Access: Solar Planning Recommendations for Local Communities

AUTHOR: CENTRAL NAUGATUCK VALLEY REGIONAL PLANNING AGENCY

SUBJECT: An analysis of the legal and institutional barriers to the installation of solar energy systems and to the protection of solar access.

DATE: February 1980

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ABSTRACT: This report analyzes the existing legal and institutional barriers to the installation of solar energy systems and to the protection of solar access caused by land use regulations and policies in the Central Naugatuck Valley Region. The report identifies specific barriers in zoning, subdivision, inland wetland, historic district, building code, and public health code regulations which could impede the development of solar domestic hot water systems and passive solar design concepts. Specific recommendations are provided for overcoming land use barriers to solar access and for promoting energy conscious building, landscaping and site planning design in Connecticut.

The preparation of this report was principally the responsibility of Charles Vidich, Regional Planner.

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INTRODUCTION

Solar energy systems are ready, but our land use regulations and institutions may be lagging far behind. These were the feelings of the Central Naugatuck Valley Regional Planning staff in the fall of 1978 when we approached the Northeast Solar Energy Center (NESEC) for a grant to study our Region's legal and institutional barriers to solar access.

At about the same time, the Connecticut General Assembly passed Public Act 78-314,

allowing energy to be a consideration in the land use planning process. The passage of this Act, along with the rising cost of conventional home heating fuels, emphasized the importance of improving energy conservation and finding ways of using renewable energy sources through more energy-conscious land use planning.

In March 1979, the Northeast Solar Energy Center awarded the Agency a grant to study the legal and institutional barriers to solar access, with the understanding that our central focus would be an analysis of the legal barriers associated

with local land use regulations. Consequently, our study is primarily an analysis of zoning and subdivision regulations insofar as they affect the installation of solar energy systems, and as they may interfere with solar access.

Our study emphasizes an incremental approach toward planning for solar energy; first, by encouraging planning and zoning commissions to evaluate the barriers to solar access in their zoning and subdivision regulations, second, by recommending alternatives to existing regulations which would permit the use of solar energy systems and third, by adopting regulations which provide

financial incentives for developers to introduce energy efficient solar heated dwellings. The final step may eventually be to require solar energy systems for space heating and domestic hot water on all new dwelling units with suitable solar access.

The mandatory use of solar energy is not unprecedented; it is being tried in

Davis, California, San Diego, California, and other counties and municipalities in the western part of the United States. However, in Connecticut, state enabling legislation limits the authority of planning and zoning commissions to merely encouraging the use of solar and other renewable energy sources. For this reason, we have recommended incentive regulations as the most suitable technique for introducing solar energy considerations into local land use

planning.

This study focuses on the legal and institutional local land use process barriers to passive solar design concepts, and to active and passive solar energy systems used for domestic hot water. It is generally acknowledged that passive solar energy design concepts and active solar energy systems used for heating domestic hot water are the two solar options which are most competitive with conventional

fossil fuels in the New England area. Nonetheless, our land use analysis is also applicable to the other more expensive active solar energy systems used for space heating, and to photovoltaic cells used for the generation of electricity.

The term "solar energy" has come to mean a wide variety of things, depending upon the perspectives of each organization. The federal government has defined solar energy to include energy received from the sun directly in the form of radiant energy, and indirectly in the form of radiant energy stored in biomass (i.e., wood, vegetation and organic solid wastes), heated surface waters, the kinetic energy of wind, and the potential and kinetic energy of water elevated via the hydrological cycle.

In turn, "solar energy systems" include an even broader realm of concepts, designs, and components which are essential to the utilization of solar energy. As used in this study, the term "solar energy system" includes both active and passive methods of deflecting, collecting and distributing solar energy for space heating

and cooling, and domestic hot water. Active solar energy systems require an external energy source (i.e., pumps, fans) to transfer the thermal energy from the collectors to the place of use. In contrast, passive solar energy systems transfer thermal energy by natural forces of convection, radiation and conduction with the use of heat storage devices acting as heat flow control mechanisms. Generally, passive solar energy systems utilize natural features of the environment (earth mass) and architectural components of the building to collect and store energy.

Legal and Institutional Barriers to the Installation and Use of Solar Energy Systems

Solar energy may face numerous constraints to its widespread use because of limitations imposed by municipal land use regulations. Land use regulations can limit the development of solar energy by controlling the siting of some types of solar energy systems, and by permitting adjoining property owners to build structures or buildings that could create solar shading problems.

A. Legal Barriers to the Installation and Use of Solar Energy Systems

Although there are no local regulations which specifically prohibit the installation of solar energy systems in any of the 13 municipalities of the Central Naugatuck Valley Region,* there are many regulations which could serve as barriers under certain conditions and at certain locations. Most of the potential barriers identified in the Region's zoning regulations are associated with the installation of solar energy systems on buildings not originally designed and sited with the thought of using a solar energy system.

The specific local regulations, which may be the strongest legal barriers to the installation of solar energy systems are: lot size, maximum ground coverage regulations, setback requirements, maximum coverage of rear yard by accessory buildings, projections into required setbacks, building height exceptions, non-conforming buildings and lots, accessory use heights, performance standards for lighting and glare, fence heights, minimum floor area requirements, earth-sheltered housing, attached greenhouse regulations, and steep slope regulations.

*Beacon Falls, Bethlehem, Cheshire, Middlebury, Naugatuck, Oxford, Prospect, Southbury, Thomaston, Waterbury, Watertown, Wolcott, and Woodbury.

1. Lot Size

Minimum lot size requirements in high density residential neighborhoods may not always provide sufficient space on the lot for the installation of solar energy systems. This problem is particularly serious in the developed urban areas of Waterbury, Watertown, Naugatuck, and Cheshire where existing houses are often improperly oriented on small lots, and have insufficient minimum setbacks from neighboring property to assure solar access. This problem is aggravated to a large extent by the hilly topography in the Region. Steep slopes facing to the north, east or west can increase shadow lengths at various times of the day, thereby reducing the potential sites available for installing solar collectors or passive solar design concepts, such as south facing window walls, attached greenhouses or roof ponds.

In the comparatively small lot zones of the Region (20,000 square feet or less), minimum lot size requirements may pose a barrier to the installation of passive solar design concepts utilizing south facing walls.* This is particularly a problem in developed neighborhoods where solar access was not a consideration in the original design and layout of the subdivision. Nonetheless, it is not the lot size requirement, by itself, which creates a barrier to the utilization of solar energy systems; it is the regulations associated with small lot sizes which create the specific barriers.

1.1 Recommendation

There is no need to increase minimum lot size requirements to protect solar access or ensure the widespread application of passive solar design concepts in high density residential zones. This is not to imply that small lots create no

*By virtue of restrictive zoning practices in the Region, only 9.4% of all the Region's vacant residential land allows for lot sizes of 20,000 square feet or less. This fact suggests that most of the barriers associated with passive solar design on small lots will be for retrofit designs.

Constraints on the siting of solar energy systems. Rather, it is to emphasize that other land use controls can compensate for the limitations associated with the use of solar energy systems on small lots. If this approach is taken, solar energy systems will not conflict with the goal of providing affordable housing (including low cost land and land improvements) in the Region. With proper planning at the neighborhood level, small lots need not pose a barrier to solar energy systems since building lot orientations, lot line orientations, street orientations and setback requirements can be coordinated to ensure that each house is adequately separated from the shadow projections of other structures and objects.

2. Maximum ground coverage regulations

Based on an analysis of the maximum ground coverage standards of the Region's 13 municipalities, it appears that an individual who intended to install solar collectors on the ground may be faced with some problems in the small lot zones of Naugatuck, Waterbury and Watertown. If we base our analysis on the minimum lot size allowable in each zone, the R-4 zone (with utilities present) in Beacon Falls would allow only 1500 square feet of coverage; the RA-1 zone in Naugatuck, 1250 square feet; the RL zone in Waterbury, 1800 square feet; and the R-10 zone in Watertown, 2500 square feet. Assuming that a homeowner had built a home that met or approached the maximum ground coverage, and was unable to install a solar collector on the roof, the local zoning commission could disapprove the installation if the collector panels increased the amount of ground coverage beyond that allowed on the lot. Maximum ground coverage regulations appear to be a real barrier to the development of solar domestic hot water systems in those cases where a number of ground-mounted solar collector panels are contemplated, and where development occurs on lots of less than 15,000 square feet. (See Table 1.)

In contrast to the high density residential zones in the Region's urban core, the suburban municipalities appear to have adopted maximum ground coverage regulations which create few, if any, problems for the installation of detached solar collectors.

Table 1: Maximum Allowable Ground Coverage by Lot Size of Buildings and Other Structures Assuming Development Occurs on the Minimum Lot Size Allowed in Each Zone of the Central Naugatuck Valley Region

Municipality	Order	Maximum Ground Coverage in Square Feet					
		10,000 to 19,999	20,000 to 29,999	30,000 to 39,999	40,000 to 49,999	50,000 to 59,999	60,000 to 79,999 and Over
Beacon Falls	1500	2250/2500/3750 ¹	N.S.	N.S.	N.S.	-	-
Bethlehem	-	-	-	-	-	-	-
Cheshire	-	-	3,000	-	4,000	-	8,000
Middlebury	-	-	3,000	-	4,000	-	8,000
Naugatuck	1250/1600/2000 ²	3,000	-	4,500	-	-	-
Oxford	-	-	-	-	-	-	-
Prospect 3	-	-	-	-	6,000	-	12,000
Southbury	-	-	4,000	6,000	4,000	-	8,000
Thomaston ⁴	-	-	N.S.	N.S.	N.S.	-	-
Waterbury	1800/1875 ⁵	-	-	-	-	-	-
Watertown	2250	2500/4500 ⁶	4,000	-	-	-	9,000
Wolcott	-	-	-	N.S.	N.S.	N.S.	-
Woodbury	-	-	-	-	4,800	-	6,000
							8000/10,000 ⁷

N.S. = not specified. Thomaston, which does not specify maximum lot coverage, uses maximum floor area ratios as a substitute.

Note: Lot size categories which are blank (-) indicates that there is no zoning district specifying this lot size.

(see page 5 for footnotes)

Cheshire, Middlebury, Southbury, and Watertown allow for 8,000 square feet of ground coverage for the minimum sized lot allowed in their largest lot zones. In the case of Oxford, the maximum coverage is 13,068 square feet, and 12,000 square feet in the case of Prospect. It is highly unlikely that anyone wishing to install detached solar collectors would be affected by these liberal standards. The only exception might be if a homeowner intended to install a vast field of collectors in order to export energy for space heating purposes to other dwellings in the neighborhood.

Maximum ground coverage regulations may also create barriers for individuals wishing to experiment with passive solar concepts, such as adding a greenhouse connection onto their home. As with domestic hot water systems, this problem is most likely to arise in high density residential zones (minimum lot sizes of 15,000 square feet or less), where an existing building has already reached the maximum allowable ground coverage limit.

2.1 Recommendation

Solar energy systems should be exempted from the standards for maximum ground coverage in all residential zones. This could be done by specifically excluding solar energy systems from the definition of a structure and by basing maximum ground coverage solely on the maximum floor area coverage of structures.

3. Setback Requirements

Minimum setback requirements may be one of the strongest barriers to the installation of ground-mounted solar collector panels. Individuals who are living in dwelling units which are built to the town's minimum setback requirements, would, in many cases, be unable to install a ground-mounted solar collector. None of the Region's 12 municipalities with zoning regulations allow accessory buildings in the front yard when the principal building has been built to minimum front yard setback requirements. In addition, three municipalities (see Table 2) categorically

Table 2: Regulations Governing the Location of Accessory Buildings in Residential Zones of the Central Naugatuck Valley Region

Municipality	Accessory Buildings Allowed in Front Yard	Accessory Buildings Allowed in Side Yard
Beacon Falls	Yes ¹	Yes
Bethlehem	No Zoning Regulations	
Cheshire	Yes ¹	Yes
Middlebury	Yes ¹	Yes
Naugatuck	Yes ¹	Yes
Oxford	Yes ¹	Yes
Prospect	Yes ¹	Yes
Southbury	Yes ¹	Yes
Thomaston	Yes ¹	Yes
Waterbury	No	No
Watertown	No	Yes ²
Wolcott	Yes ¹	Yes ³
Woodbury	No	Yes

¹As long as accessory uses or buildings meet minimum front yard setback requirements established for principal building.

²Only accessory uses with heights of less than 20 feet and less than 530 square feet of floor area may meet lesser setback requirements from street line making a sideyard location possible.

³As long as accessory building is at least 75 feet from the street line.

Source: CNVRPA staff work based on zoning regulations in each municipality, June 1979.

prohibit accessory uses or buildings in the front yard, even when the principal building has sufficient front yard to allow another building, or structure, without violation of the front yard setback requirements.

Accessory uses or structures are allowed in rear yards in every municipality, and, with the exception of Waterbury, accessory uses are also allowed in the sideyards of every municipality in the Region. However, when the principal building has been built to minimum side or rear yard setback requirements, six of the Region's municipalities prohibit accessory uses in side or rear yards. In contrast, six municipalities allow accessory uses in the side or rear yard even when the principal building has been built to the minimum setback requirements. This approach facilitates the siting of detached ground-mounted solar collector panels in small lot zones where there is little available side or rear yard space. But, if the solar collector panels are attached to the wall of the house, as with a greenhouse connection, the solar installation would no longer be an accessory use, and would be required to meet the minimum setback standards for the principal building.

Accessory uses or structures built in Waterbury are required to be set back 10 feet from the principal building. This regulation may be unduly restrictive for individuals installing detached ground-mounted solar collectors, and who wish to locate their installation as near as possible to the house to reduce heat losses.

None of the Region's municipalities allow for zero lot lines for the principal building. This policy may unnecessarily discourage the use of passive solar design concepts in small lot zones where minimum setback requirements are too inflexible to guarantee solar access for south facing walls. The prohibition against development at the lot line also eliminates the opportunity for sharing common walls in attached housing, or in sharing greenhouse connections with neighbors.

3.1 Recommendation

Solar energy systems used for space heating and domestic hot water should be a permitted use in all front, side and rear yards, and should be allowed to meet less restrictive setback requirements than the principal buildings. This could be accomplished quite easily by exempting solar energy systems from the definition of building, accessory building or structure. This approach provides greater flexibility in the siting of solar energy systems on small lots where ground solar access may be minimal.

Minimum setback requirements for the principal building should also be made more flexible to encourage: (1) the use of passive solar design concepts in individual dwellings; (2) the shared use of passive solar energy systems such as greenhouses; and (3) the use of energy conservation techniques such as common walls in attached or row housing developments.

In particular, where an entire subdivision is planned specifically for solar use, minimum setback requirements should be waived so that the developer has the maximum opportunity for siting buildings to protect solar access and for utilizing common walls as in attached housing. In order to ensure that solar energy is used, planning commissions should condition the approval of the subdivision map and the sale of lots on the proper installation of solar energy systems in each dwelling unit. Under these conditions, performance standards for solar access would supercede the setback standards established for conventional non-solar subdivisions.

4. Maximum Coverage of Rear Yard by Accessory Buildings

For those who may consider installing a large number of solar panels in their rear yard, there may be some limitation on the location and number of panels that can be installed if the panels are considered as accessory structures. Three municipalities limit the maximum ground coverage of accessory buildings to 20% (Middlebury

and Wolcott), or 25% (Waterbury) [see Table 3]. An individual with a small backyard already partly used for other structures could be denied the use of solar collectors if the collectors violated the maximum ground coverage standards for accessory uses. As an example, a house built in Middlebury's half acre zone, which had the minimum required rear yard, may have no more than 1,875 square feet of yard space, of which a maximum of 20%, or 375 square feet, could be used for accessory buildings or structures. If an accessory structure already is in place and consumes most or all of the allowable ground coverage, then a solar collector would not be allowed on the ground. However, the collectors could be placed on the roof of the accessory building if the orientation of the building and the pitch of the roof were suitable.

The regulation for maximum coverage of rear yard by accessory buildings does not pose any barriers to the use of passive design concepts, such as a greenhouse connection to the principal structure. However, if a greenhouse connection is contemplated as a supplementary heat source for an accessory building, then it, too, would be subject to the maximum ground coverage limitations for accessory buildings in the three municipalities (Middlebury, Waterbury and Wolcott) which have adopted this specific regulation.

4.1 Recommendation

Solar energy systems should be exempted from the standards for maximum ground coverage of rear yard by accessory buildings. This recommendation could be implemented by excluding solar energy systems located on the ground from the definition of an accessory use.

5. Projections into Required Setbacks

None of the Region's municipalities allow the projection of the building structure into the required front, side or rear yards. Consequently, solar energy systems would not be permitted to project into the required yard area unless they were

Table 3: Regulations Governing the Size, Coverage and Height of Accessory Buildings and Structures in Residential Zones of the Central Naugatuck Valley Region

Municipality	Maximum Allowable Height of Accessory Buildings (feet) ¹	Maximum Allowable Floor Area (square feet)	Reduced Minimum Setback for Accessory Buildings	Setback Requirements for Accessory Buildings (feet)	Maximum Allowable Coverage of Rear Yard by Accessory Buildings (percent)
Beacon Falls	N.S.	N.S.	N.S.	-	N.S.
Bethlehem	----- No Zoning Regulations -----				
Cheshire	12	N.S.	Yes	5	N.S.
Middlebury	12	N.S.	Yes	15	20
Naugatuck	15	576	Yes	5/10 ²	N.S.
Oxford	N.S.	N.S.	N.S.	-	N.S.
Prospect	N.S.	N.S.	N.S.	-	N.S.
Southbury	N.S.	N.S.	N.S.	-	N.S.
Thomaston	N.S.	N.S.	N.S.	-	N.S.
Waterbury	15	N.S.	N.S.	-	25
Watertown	N.S.	N.S.	Yes	10/5 ³	N.S.
Wolcott	12	N.S.	Yes	8 ⁴	20
Woodbury	N.S.	*** ⁵	Yes	5 ⁶	N.S.

N.S. = not specified

¹Presumably, where no maximum height limitation has been established, accessory buildings may be regulated by the maximum height limitations governing principal buildings.

²R8, RA1 and RA2 Zones = 5 feet R30, RL5 Zones = 10 feet

³R20, R60 and R80 Zones = 10 feet RL0, RA, RG Zones = 5 feet

⁴The Wolcott Zoning Regulations allow adjoining owners to build accessory buildings on the property line by their mutual agreement.

⁵The maximum floor area of the accessory building cannot be greater than the ground floor of the principal building if it is used for guest quarters, or purposes other than animal quarters.

⁶Accessory buildings which are 12 feet high must be setback 20 feet from the property line.

Source: CNVRPA staff work based on zoning regulations of each municipality, April 1979.

designed to mimic architectural features such as cornices, canopies or marquees.

In the Central Naugatuck Valley Region, architectural features are allowed to

extend anywhere from one foot (Wolcott), to three feet (Cheshire, Southbury and Watertown) into the required yard area (see Table 4).

The restrictions on projections into yard areas can have an impact on four

different types of solar energy systems: solar collector panels, solar reflectors, solar shading devices for south walls, and solar shading devices for roof ponds.

It is conceivable that these components of the solar energy systems may require additional overhang into required yard area in order to ensure the proper functioning of the solar energy systems. (See picture on page 14.)

5.1 Recommendation

Solar energy systems, including apparatus such as solar collectors, solar reflectors, solar shading devices for south walls and solar shading devices for roof ponds, should be exempted from the regulations governing projections into required yard areas.

6. Building Height Exceptions

None of the Region's 12 municipalities with zoning regulations explicitly exempt solar collector panels, solar reflectors, storage tanks, roof ponds or rooftop greenhouses from the height limitations imposed for buildings (see Table 5). Although heating and air conditioning equipment are exempted from height restrictions, this broad term would not be sufficient to exempt solar collectors or other similar structures. Since none of the municipalities make reference to solar collector panels, solar reflectors, roof ponds or rooftop greenhouses as structures exempt from the maximum height limitations of the zone, zoning commissions will probably interpret their regulations to exclude these types of structures. Consequently, height exception regulations could be a barrier to the installation of rooftop

Table 4: Maximum Projections into Required Setback Areas and
Maximum Height of Fences in the Central Naugatuck
Valley Region: 1980

Municipality	Maximum Projection Allowed into Required Setback (feet)	Maximum Allowable Height of Fences (feet)
Beacon Falls	N.S.	6
Bethlehem	---- No Zoning Regulations ----	
Cheshire	3	8
Middlebury	N.S.	6
Naugatuck	2	6
Oxford	N.S.	N.S.
Prospect	N.S.	N.S.
Southbury	3	6
Thomaston	N.S.	N.S.
Waterbury	2	N.S.
Watertown	3	6
Wolcott	1	6/4 ¹
Woodbury	N.S.	No Limit

N.S. = not specified

¹ 6 foot fence allowed in front yard; 4 foot fence allowed in side or rear yard.

Source: CNVRPA staff work based on the zoning regulations of each municipality,
January 1980.



Some solar collectors could violate zoning regulations governing projections into required yard area.

Table 5: Exceptions to Maximum Height Limitations Allowed in the Central Naugatuck Valley Region: 1979

Municipality	Structures and Equipment Specified as Exempt from Height Limitations														
	Roof structures	Elevator shafts	Tanks	Ventilating fans	Heating or air conditioning units	Other structures used to operate building	Towers, bellies, cupolas	Steeples, spires	Flag poles	Chimneys	T.V. & domestic radio antennas	Water tanks	T.V. & radio transmitters	Farm silos	Town buildings or structures
Beacon Falls															
Bethlehem															
Cheshire															
Middlebury															
Naugatuck															
Oxford															
Prospect															
Southbury															
Thomaston															
Waterbury															
Watertown															
Wolcott															
Woodbury															

Foot structures are allowed as long as they are screened from view.

Source: CWRPA staff work based on the zoning regulations of each municipality, May 1979.

solar energy systems in those cases where a flat roofed building was built to the maximum height limitation of the zone. However, for the typical pitched roof colonial or suburban home, it is unlikely that solar collectors will be placed at a higher elevation than the peak of the roof - although this possibility may exist where severe solar shading affects most of the lower portion of the rooftop.*

6.1 Recommendation

Solar energy systems including solar collector panels, storage tanks, rooftop greenhouses, solar reflectors, and roof ponds should be exempted from building height restrictions. However, some maximum height limitations should be considered for the exempted structures in order to avoid the possibility that components of a solar energy system cast shadows on neighboring property.

7. Nonconforming Buildings and Lots

One of the most troublesome areas for owners of older homes may be the regulations for nonconforming buildings and lots. Typically, the zoning regulations in the Central Naugatuck Valley Region do not allow for the extension or enlargement of a nonconforming building, unless that leads to a building which is more conforming, or in conformity with the current regulations for the zone. The installation of detached solar collectors, greenhouse connections, or any passive design concepts which alter the size or outer appearance of a building on a nonconforming lot, would be violations of the zoning regulations in seven municipalities in the Region (Beacon Falls, Middlebury, Naugatuck, Oxford, Southbury, Watertown and Wolcott). This is a serious barrier to the widespread use of solar energy systems, since there are many building lots in the urbanized portion of the Region in present violation of current standards for setback, lot size or frontage requirements.

*Indeed, one of the known 35 operating solar domestic hot water systems in the Region has solar panels placed above the peak of a pitched roof.

However, there may be some ground for allowing the installation of solar collector panels, or the introduction of passive solar design concepts into buildings on non-conforming lots. Zoning regulations do allow for reasonable repair of a building required to protect the public health and safety. Consequently, the alteration or improvement of buildings to allow passive solar design concepts and solar collectors could be interpreted as within the definition of "reasonable repairs," if energy considerations are allowed to play a greater role in the land use planning process.

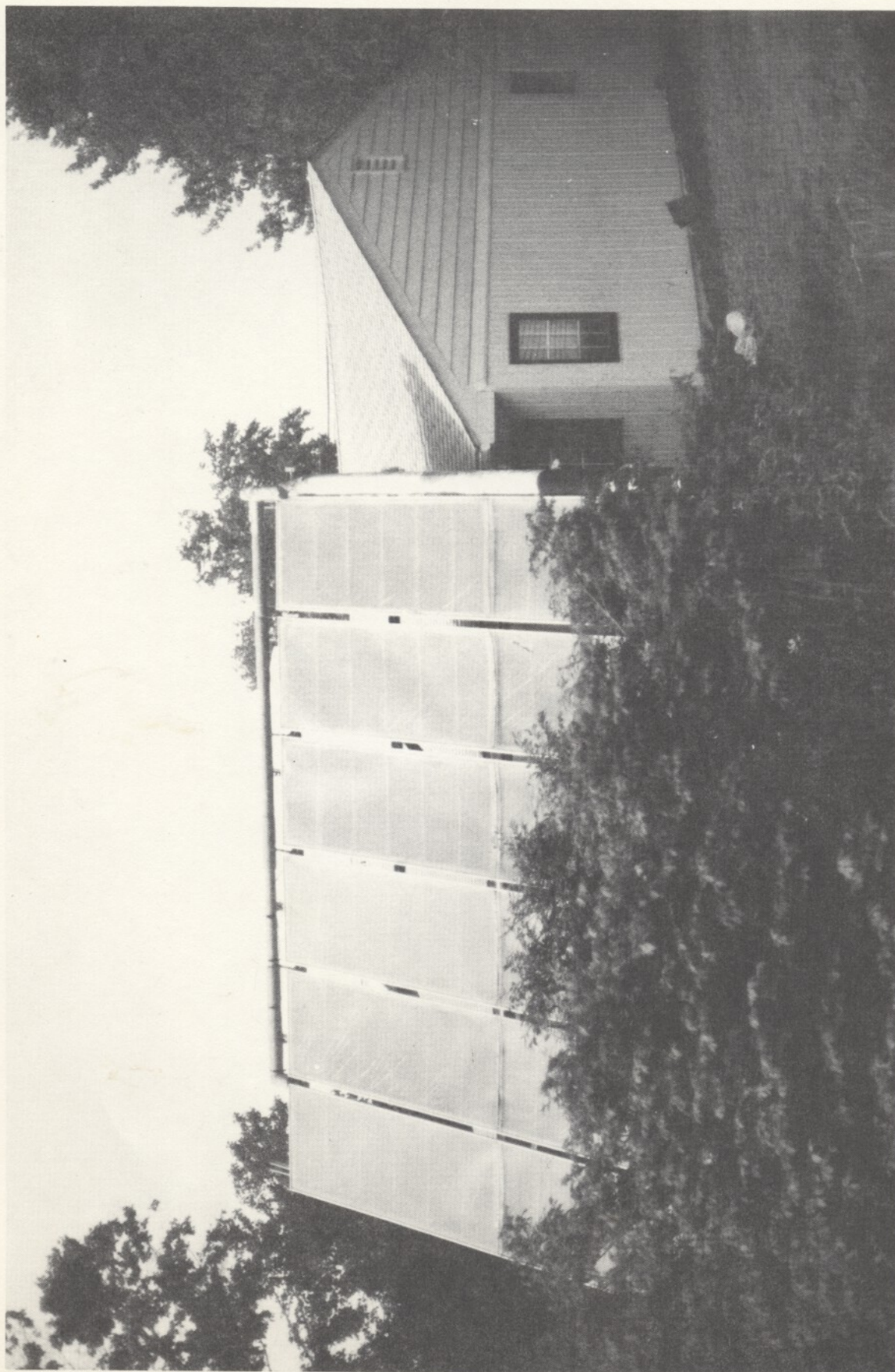
7.1 Recommendation

The installation of solar collector panels should be allowed as a matter of right on all nonconforming buildings. However, structural alterations of the building or expansions should be permitted, subject to obtaining a variance from the local zoning board of appeals. Variances from the zoning regulations are supposed to be granted on hardship caused by lot conditions unique to the property. Based on this approach, variances for passive and active solar energy systems could be granted if the building cannot be retrofitted for passive or active solar energy systems without alteration or structural expansion.

8. Accessory Use Heights

Five municipalities restrict the maximum height of accessory buildings to 12 feet (Cheshire,* Middlebury, and Wolcott), or 15 feet (Naugatuck and Waterbury). These height restrictions clearly limit the opportunity for installing collector panels on flat-roofed accessory buildings (such as garages, toolsheds or guesthouses), and may also limit the installation of custom-made solar collector panels when these units are over 12 feet in height. (See picture on page 18.)

*In Cheshire, guesthouses and garages are not governed by the definition for accessory buildings.



Some solar collectors could violate zoning regulations governing the maximum height of accessory structures.

8.1 Recommendation

Solar energy systems, such as solar collector panels, should be exempted from the regulations for accessory use heights. This could be accomplished by excluding solar energy systems from the definition of accessory use.

9. Performance Standards for Lighting and Glare

Eight municipalities in the Region have adopted townwide performance standards for lighting and glare which could pose barriers to the operation of solar collectors, solar reflectors, solar concentrators and passive solar design concepts utilizing reflective surfaces (see Table 6). The remaining four municipalities (Southbury, Thomaston, Wolcott and Woodbury) have also adopted performance standards for lighting and glare, but the standards are only applicable to nonresidential or industrial land uses. Solar collectors which reflect an excessive amount of light onto a neighbor's property, or onto a public highway, may be prohibited if they endanger the public health and safety, or if they impair the value of surrounding property. Six municipalities currently consider the impact glare has on surrounding property values, and three municipalities consider the impact of glare on the public health and safety, and highway safety as criteria for determining whether the glare-producing object is indeed a nuisance. The application of performance standards for glare to cover solar collectors and reflectors appears reasonable, but the criteria used to estimate the magnitude of the nuisance are generally too broad and vague to allow for an equitable administration of the regulations.

9.1 Recommendation

Solar energy systems should be regulated by glare standards for highway safety. There is no question that under certain circumstances, glare from a solar reflector or solar collector could be a cause of accidents on public highways. However,

Table 6: Performance Standards for Lighting and Glare
Applicable to the Installation and Operation
of Solar Collectors, Concentrators and Reflectors
in the Central Naugatuck Valley Region

Municipality	Specification of Townwide Performance Standards	Standards for Excessive Lighting or Glare	Criteria Cited for Evaluation of Glare		
			Impair Value of Other Lots	Endanger Public Health and Safety	Endanger Highway Safety
Peacon Falls	Yes	Yes	Yes	Yes	Yes
Bethlehem	----- No Zoning Regulations -----				
Cheshire	Yes	Yes	No	No	No
Middlebury	Yes	Yes	Yes	Yes	Yes
Naugatuck	Yes	No	No	No	No
Oxford	Yes	Yes	Yes	No	No
Prospect	Yes	Yes	Yes	No	No
Southbury	No ¹	No	No	No	No
Thomaston	No ¹	Yes	Yes	No	No
Waterbury	Yes	Yes	No	No	No
Watertown	Yes	Yes	Yes	Yes	Yes
Wolcott	No ¹	Yes	No	No	No
Woodbury	No ¹	No	No	No	No

Performance standards for Southbury, Thomaston, and Woodbury cover only non-residential land uses, and in Wolcott the standards cover only industrial uses.

Source: CNVRPA staff work based on the zoning regulations of each municipality, May 1979.

solar collectors should be exempt from glare performance standards when the issue involves the impact of glare on surrounding property values. In this case, glare performance standards could become one of the easiest tools to eliminate a neighbor's solar energy system which fails to meet one's own aesthetic standards.

11. Minimum Floor Area Requirements

In those cases where excessive glare may create a potential highway safety problem, the zoning enforcement officer could either (1) encourage the contractor or homeowner to shift the location of the collectors, (2) require that non-reflective materials (e.g., low coated iron glass, Kalwall or matte finish fiberglass glazings) be installed, or (3) require proper landscaping around the collector panels to buffer the glare problems.

10. Fence Heights

It is conceivable that solar collector panels or solar reflectors could be prohibited for violation of fence height regulations if they were installed to resemble a fence. Interviews with the Region's town planners revealed that solar collector panels could be treated as a fence in at least one municipality due to the vagueness of the local fence regulations. The application of fence height regulations to solar energy systems could probably apply only if the solar collectors were linked in a series, and served as a visual barrier on or along the property line. Under these conditions, fence height limitations would prohibit solar collector panels or solar reflectors from exceeding a height of 6 feet (Beacon Falls, Middlebury, Naugatuck, Southbury, Watertown, and Wolcott), or 8 feet (Cheshire). This would pose a barrier only to the use of custom-made solar collector panels, since most manufacturers do not make panels longer than 8 feet.

10.1 Recommendation

Subject to controls on the angle of the collector panel, the number of panels

involved, and the use of the panels as a visual barrier, solar collectors and

reflectors should be regulated under the definition of fences. This will require a revision of the local current definition of fences to provide a more precise control over the location, height, pitch and composition of the fence.

11. Minimum Floor Area Requirements

One of the principal barriers to the widespread use of solar energy systems is the cost of the equipment and its installation. This barrier is, to a large extent, aggravated by zoning regulations which require the construction of dwellings with minimum floor areas in excess of the minimum spatial needs of its occupants. Larger houses require more energy to heat, and may also require greater amounts of hot water (i.e., larger houses usually have more bedrooms, and consequently more people are using water).

10. Fence Heights

In the Central Naugatuck Valley Region, all of its municipalities with minimum floor requirements have set standards which are far in excess of those set by the American Public Health Association. These requirements are applicable to detached single family dwellings, and range from a minimum of 720 square feet in Wolcott, to 1300 square feet in Middlebury (see Table 7). Excessive minimum floor area requirements may discourage individuals interested in passive solar design concepts from incorporating these concepts into their home, since the high cost of the minimum sized house may preclude the opportunity of incorporating some of the more expensive passive solar design concepts into the home.

Assuming all other things are equal, reducing minimum floor area requirements from 1300 square feet to 750 square feet could reduce home heating costs by as much as 37%, according to a recent study prepared by the CNVRPA.* Smaller heat loads would, in turn, facilitate the installation of passive solar design concepts capable of meeting most of the heating requirements of the home.

*Central Naugatuck Valley Regional Planning Agency, Least Cost Housing: Minimizing the Fiscal Impact of Zoning and Subdivision Regulations, November 1978, p.12.

Table 7: Minimum Floor Area Requirements for Single Family Dwellings by Size of the Dwellings and Residential Zone in the Central Naugatuck Valley Region: November 1978

Municipality	In Square Feet		
	Minimum Floor Area for a 1 Story Dwelling	Minimum Floor Area for a 1-1/2 Story Dwelling	Minimum Floor Area for a 2 Story Dwelling
Beacon Falls	None	None	None
Bethlehem	1,000	1,000	1,000
Cheshire	None	None	None
Middlebury	1,300	1,300 ¹	1,300 ¹
Naugatuck	None	None	None
Oxford (RA Zone)	1,000	1,200	1,400
Oxford (RD Zone)	800	960	1,120
Prospect	960	960	960
Southbury	900	1,200	1,200 ²
Thomaston	900	900	900
Waterbury	800	800	800
Watertown (R10 Zone, R-A, RG Zones)	750	750	750
Watertown (R20 Zone)	1,000	1,000	1,000
Watertown (R60, R80 Zones)	1,200	1,200	1,200
Wolcott	720 ³	720 ³	720 ³
Woodbury	900	1,200 ²	1,200 ²

¹A minimum of 1,000 feet on first floor.

²A minimum of 800 square feet on first floor.

³The minimum floor area increases with the number of rooms in the house as follows:
3 rooms or less, 720; 4 rooms, 800; 5 rooms, 900; 6 rooms, 1,000; 7 rooms, 1,100.

Source: Central Naugatuck Valley Regional Planning Agency, Least Cost Housing: Minimizing the Fiscal Impact of Zoning and Subdivision Regulations, November 1978, p. 10.

11.1 Recommendation

Zoning regulations should not control minimum floor area requirements, since current standards have no relationship to the public health nor to the development of energy-efficient building design. However, minimum floor area standards could become a useful tool in energy conservation if they were used to control the building's surface area. A floor area to building surface area ratio could be used to control the gross heating requirements of a house, since the smaller the surface area of the house, the smaller the heating load. This ratio could be refined to provide, for example, an incentive for earth-sheltered housing, if the ratio were based on exposed building surface area so as to discount air space built below grade from the calculations (see the following section).

12. Earth sheltered housing

The use of earth mass as an insulation material for walls or roofs of homes may be indirectly discouraged in seven municipalities of the Central Naugatuck Valley Region. The zoning regulations of five municipalities (Middlebury, Southbury, Thomaston, Waterbury and Wolcott) categorically stipulate that basement areas cannot be included in the determination of minimum livable floor area requirements (see Table 8). One municipality (Oxford) excludes basements in the determination of minimum floor area requirements when the basement ceiling is less than 5 feet above ground level, and one municipality (Woodbury) excludes basements from being counted as livable floor area when windows are less than 2 feet above grade.

Furthermore, two municipalities allow basements to be included in the calculation of minimum livable floor area, but may seriously constrain the design of earth-sheltered housing by requiring that the ceiling be at least 4 feet above ground level within 10 feet of the building to be considered livable (Watertown), or by requiring that the basement be finished and have adequate heat, light and ventilation to be considered livable (Prospect).

Table 8: Required Methods of Determining Minimum Livable Floor Area Requirements in the Central Naugatuck Valley Region

Municipality	Exclusion of Basements in Determining Minimum Floor Area Requirements	Exclusion of Closed Porches in Determining Minimum Floor Requirements	Minimum Height of Ceiling for Livable Floor Area (feet)
Beacon Falls	- - - - - No	Floor Area Requirements - - - - -	- - - - -
Bethlehem	- - - - - No	Zoning Regulations - - - - -	- - - - -
Cheshire	- - - - - No	Floor Area Requirements - - - - -	- - - - -
Middlebury	Yes	Yes	None
Naugatuck	- - - - - No	Floor Area Requirements - - - - -	- - - - -
Oxford	Yes ¹	Yes	None
Prospect	No ²	No ²	None
Southbury	Yes	Yes ³	7
Thomaston	Yes	Yes	None
Waterbury	Yes	No	None
Watertown	No ⁴	Yes ³	7
Wolcott	Yes	Yes	7
Woodbury	Yes ⁵	Yes	7

¹Where basement ceiling is less than 5 feet above ground level.

²Basements and porches must be finished and contain heat, light, and ventilation adequate for minimum habitation to be included in floor area requirements.

³When not heated by a central heating system.

⁴Except basement, story must have a ceiling 4 feet above ground level within 10 feet of the building, to be considered livable floor area.

⁵Rooms partially below grade may be counted only if there is window area entirely 2 feet or more above grade, equal to 1/8th or more of the floor space in each room, and 45% of such window area can be opened.

Source: CNVRPA staff work based on the zoning regulations in each municipality, June 1979.

The greater the earth mass coverage of the walls and ceilings of an underground

house, the greater the insulation achieved from the outside air temperature.

Underground, or earth-sheltered houses, take advantage of the moderating influence of the earth's mass. In the summer, temperatures in an earth-sheltered house are

lower than the outside air, due to the cooling influence of the earth's mass.

Similarly, in the winter, the temperatures in an earth-sheltered house are warmer than the outside air due to the warming influence of the earth's mass.

The greatest benefits to be derived from the application of the passive solar

design concepts associated with earth insulation and earth heat storage are for dwellings which have most, if not all, of their walls and roof below grade.

Zoning regulations which require that basement ceilings be at least 5 feet above grade, or require window configurations which expose large portions of the wall to the outside air, tend to reduce the effectiveness of earth insulation and earth heat storage principles.

12.1 Recommendation

Zoning regulations should be revised to allow earth-sheltered housing to meet the minimum requirements for habitable floor space. Current regulations stipulating standards for natural lighting should be re-evaluated, since no consideration is given to alternative energy-efficient lighting concepts including skylights, atriums and window walls on side slopes of hills. Furthermore, zoning regulations should not stipulate the height of a basement ceiling above grade, since this reduces the value of using earth mass as an insulating cover over the dwelling.

13. Attached Greenhouses

Home heating bills can be reduced considerably by the use of passive solar design concepts, such as the attached greenhouse and the expandable house. In simple terms, an attached greenhouse serves as a supplementary furnace to a home by

collecting solar radiation and transmitting it into the dwelling. An attached greenhouse does not require conventional forms of heating since it generates heat on its own.

Furthermore, attached greenhouses are rarely used for living purposes, so the heat it generates during the daylight hours is sufficient for its normal use. It can be closed off during the evening to avoid heat loss, and it can be opened during the day to provide heat. In theory, an entire dwelling can thus be

heated on the same principle as a greenhouse by making use of the south walls and roof of the house as solar collection systems. Using this approach, it may not be necessary to provide much additional heat, other than the sun, to keep a dwelling warm.

Despite the advantages of the solar greenhouse, seven municipalities in the Region (Middlebury, Oxford, Southbury, Thomaston, Watertown, Wolcott and Woodbury) categorically stipulate that closed porches (attached greenhouses) cannot be included in the determination of minimum habitable floor area requirements (see Table 8). Consequently, an individual wishing to heat his/her home, or a portion of the home, exclusively by solar greenhouses, would be prohibited by seven of the 12 zoning regulations in the Region. Two of the seven zoning regulations (Southbury and Watertown) go so far as to stipulate that closed porches (attached greenhouse) can only be counted towards the minimum habitable floor area when the porch (greenhouse) is heated by a central heating system. This requirement eliminates the value of installing an attached greenhouse, or of making an expandable house (where certain rooms are unheated) to meet one's minimum spatial needs. In effect, by requiring that all rooms of a house be heated (and in some cases by a central heating system), local zoning commissions have unknowingly overlooked the sun as a valid source of heat.

13.1 Recommendation

Zoning regulations should be revised to allow properly insulated greenhouses and solar porches to meet the requirements of minimum habitable floor area as long as the floor area of the attached greenhouse does not exceed 30% of the total floor area of the dwelling. In addition, zoning regulations should not stipulate the method of heating used in a dwelling, nor require that all rooms be fully heated by central heating systems in order to be considered habitable.

14. Steep Slope Regulations

South facing slopes are the ideal location for the siting of passively heated solar homes, or for the installation of solar collector panels. However, this opportunity may be precluded in most municipalities by regulations which discourage development on slopes of 15% or more, or by regulations which prohibit the construction of driveways with slopes of 10% or more (Waterbury), or 12% or more (Southbury).

In Southbury, development on steep slopes is largely controlled by the driveway regulations which require grades to be under 12%. In those instances where a dwelling is constructed on slopes of 12% or more, the planning commission has an "informal" policy of prohibiting house construction on slopes of 25% or more. In Woodbury, there is no grade requirement for driveways, and no prohibition of building on steep slopes. But as a practical matter, the Woodbury Town Planner indicated that development on slopes of 15% or more is difficult to accomplish without serious environmental problems. Unless the developer creates large lots, or clusters the lots, the Woodbury Planning Commission discourages development on steep slopes in order to avoid the excessive amount of cutting and filling involved in road construction and house foundations. The Woodbury Town Planner emphasized that steep slopes are harder to work with, but acknowledged that they offer better opportunities for solar orientation, earth-sheltered housing design, and for the use of earth or vegetative wind barriers on northerly exposures.

14.1 Recommendation

Development on steep south facing slopes should be encouraged and at higher densities than currently allowed by the Region's zoning regulations. Development on appropriate slopes of up to 20% is feasible at only slightly higher costs than on a flat site. However, environmental problems of erosion and sedimentation are likely to be increased for certain types of soil conditions when slopes exceed 15%. New zoning regulations for lot size could be established which considered a series of environmental factors, so that solar access might be balanced with soil, water and public utility elements. A new zoning map based on a rating of the land in town for solar access, soil suitability for septic system leaching fields (where sewers are unavailable and on-site community leaching systems are not possible), and soil erodibility factors associated with each soil type is an example. This type of approach may be used to increase densities on south facing slopes, where environmental concerns are found to be insignificant; and to decrease densities on north facing slopes, where solar radiation is minimal and where energy requirements are likely to be considerably greater due to exposure to north winds in the winter.

There is a potential danger that decreasing densities for north facing slopes could result in a pattern of exclusionary zoning in some municipalities. In order to evaluate the magnitude of this problem, the CNVRPA analyzed the orientation and slope of all land in Cheshire and Woodbury. Based on our analysis, about 60% of all the land in Cheshire was oriented to the south, southeast, southwest, or was flat. Similarly in Woodbury about 48% of the land was oriented to the south, southeast, southwest or was flat. This indicates that in at least these two municipalities, zoning for solar access would be consistent with maintaining an overall pattern of higher density development. (See Appendix 4.)

B. Institutional Barriers to the Installation and Use of Solar Energy Systems

Solar energy systems may also face serious institutional barriers posed by the administration of formal and informal land use policies of the Planning and Zoning Commissions, Inland Wetland Agencies, Historic District Commissions, the Town Sanitarian and the Town Building Inspector. Under state enabling legislation, each one of these commissions and agents has authority under certain circumstances to regulate the installation and use of solar energy systems.

These commissions may retard the development of solar energy systems in two distinct ways: (1) by prohibiting or discouraging solar energy systems which conflict with their informal or formal policies and, (2) by creating needless regulatory delays which lengthen the process of obtaining approval to install solar energy systems. Figure 1 summarizes all the possible permits and procedures required to install a solar energy system in Connecticut. While most solar energy systems will require only a building permit (rooftop locations), other permits may be needed when solar collectors are located on the ground to serve industrial or commercial buildings (site development plan); in backyards of residential buildings (zoning permit); on historic buildings (certificate of appropriateness); in wetland areas (wetland permit); or in close proximity to a septic system leaching field (septic tank permit); or water well (water well permit). Furthermore, when solar energy systems are installed within a new residential subdivision, a plot plan, subdivision map, architectural plans and site development plan may be required if the location of the collectors is separate from the dwelling. When the solar energy system is incorporated into the design of the house, the planning commission can also play a critical role in the siting and orientation of the buildings, lots, and street which may affect solar access.

1. Discretionary Powers of the Planning Commission

Planning commissions are charged with the regulation of the subdivision of land, and have been given broad authority to accomplish this mandate. Since the passage of Public Act 78-314, which allows energy to be a consideration in land use planning, Connecticut planning commissions "...may also encourage energy-efficient patterns of development, the use of solar and other renewable forms of energy, and energy conservation...." The presence of prescriptive enabling legislation encouraging the use of solar and other renewable forms of energy removes any possible legal disputes over the place of energy in the land use planning process in Connecticut.

However, the presence of enabling legislation supporting the use of energy as a consideration in the planning process has apparently not yet filtered down to the local level, nor resulted in the modification of any of the Region's subdivision regulations. Interviews held with the four Town Planners in the Region (Cheshire, Southbury, Waterbury and Woodbury) revealed that none of the planning commissions has yet discussed Public Act 78-314, and only a few of the commission members are aware of the fact that energy is allowed to be a consideration in the land use planning process. Lacking awareness of the role to be played by energy in the planning process, commission members have relied on traditional approaches for regulating the subdivision of land. This present lack of understanding among planning commission members represents one of the most serious institutional

barriers to the future use of solar energy in Connecticut. For example, a planning commission can effectively limit the future retrofit market for solar domestic hot water systems by continuing to approve subdivision plans where lots and dwellings are improperly oriented to the sun. Furthermore, a planning commission may easily delay the widespread acceptance of passive solar design concepts by failing to offer incentives to developers willing to experiment with solar energy systems.

Finally, a planning commission may unknowingly support the development of subdivisions which unnecessarily increase the energy consumed for home heating by failing to allow for clustered development, zero lot lines, higher density development and more reasonable minimum floor area requirements. Under Connecticut state enabling legislation, planning commissions can encourage, if not require, proper solar orientation of building lots, street designs that foster the division of land into lots having southerly orientations, the development of energy-efficient landscaping or terrain patterns, and the development of incentive regulations which require developers to include energy conservation principles in site planning, install solar energy systems, or construct energy efficient building designs.

There are at least seven subdivision standards for planning and design which could, with some modifications, be used to encourage (1) solar energy systems, (2) energy efficient landscaping, and (3) energy efficient building designs. These seven standards are as follows: building orientation, lot orientation, street orientation, open space dedication, design of terrain and trees, densities and street grade. While planning commissions in the Region have made extensive use of these seven subdivision standards, they have not yet utilized these standards from the perspective of conserving energy or promoting the use of solar energy systems. Consequently, the manner in which each of these standards is currently being administered represents, in fact, seven specific institutional barriers to the use of solar energy.

Under Public Act 78-314 planning commissions in Connecticut also have the opportunity of establishing entirely new standards for regulating the energy efficiency of building design and for optimizing the use of passive solar design concepts. For example, planning commissions could (1) condition the approval of subdivision maps on the proper construction of roofs with optimum orientation and pitch suitable for the installation of solar domestic hot water systems, (2) they could require developers to meet minimum standards for solar access (i.e., rooftop access

or south facing wall access) in the design and layout of buildings and terrain, or

(3) they could establish incentives which would be offered to developers who agreed to install solar domestic hot water systems in new developments built with solar energy in mind. A detailed discussion of each of the institutional barriers and incentives is addressed below.

a. Building Orientation

Generally, the orientation of a building depends upon the orientation of its lot. In turn, the orientation of the lot often depends upon the orientation of the street or roadway fronting the lot. This step-down relationship between street orientation and building orientation has generally led to an almost random pattern of orienting buildings with respect to the sun. Based on a CNVRPA analysis of 1970 aerial photos in Cheshire, Southbury, Waterbury and Woodbury, it appears that building orientation and roof pitch may be significant barriers to the future solar retrofit market. In 1970, the total number of buildings (including buildings used for dwellings, barns, commercial, business and manufacturing), with orientations suitable for retrofitting of solar domestic hot water systems, was approximately 11% in Southbury, 13% in Waterbury, 18% in Woodbury and 26% in Cheshire.

The CNVRPA survey of building orientations included all buildings with a southerly roof pitch, or a roof pitch which was within 15 degrees of a true southerly exposure. As can be seen in the Table below, a total of 6,354 buildings were identified as potentially suitable for retrofitting solar domestic hot water systems in the municipalities of Cheshire, Southbury, Waterbury and Woodbury. Most of the buildings that were suitable (5,391 buildings) in 1970 were residential buildings with pitched roofs. Moreover, the survey identified 863 flat roofed buildings used primarily for commercial, business or manufacturing purposes which would also be suitable for retrofitting solar domestic hot water systems.

The Potential Market for Solar Retrofitting in Four Selected Municipalities in the Region: 1970

Municipality	Total Potential Retrofit Market in 1970	Number of Buildings with Pitched Roofs having Southerly Exposure*	Number of Flat Roofed Buildings
Cheshire	2,282	2,047	135
Southbury	444	370	74
Waterbury	3,112	2,545	567
Woodbury	516	429	87
Total	6,354	5,391	863

*Southerly exposure included all buildings with roofs pitched within 15 degrees of true south and which had sufficient roof space to accommodate 2 solar collector panels 8 feet by 4 feet in size.

Source: CNVRPA staff survey of 1970 aerial photographs of Cheshire, Southbury, Waterbury and Woodbury, July 1979.

The limited number of buildings with southerly orientation in 1970 suggests that there is a strong need for subdivision incentives or mandates to encourage proper solar orientations on all new buildings.

The orientation of buildings is generally the most important factor in the proper siting of rooftop solar collectors, or the integration of passive solar design concepts into a building.

Buildings which are oriented along an east-west axis maximize their exposure to the sun and facilitate the installation of solar collector panels and passive solar design concepts into the building. Of course, the integration of rooftop solar collectors on a building oriented on an east-west axis will depend upon the orientation of the roof. A square building might very well have roofs sloping to the east and west, which would discourage the installation of solar collector panels on the roof.

a.1.1. Recommendation

Planning commissions should not only encourage the siting of buildings on an east-west axis, but should offer incentives (if necessary) for developers to pitch the roof at the proper angle to the south. That way, collector panels can easily be installed on the roof at the time of construction, or at some future point in time when the homeowner has an interest in solar energy systems.

c. Street Orientation

b. Lot Orientation

The subdivision of land into building lots is a powerful tool for shaping the future location and orientation of buildings within a neighborhood. Generally, planning commissions encourage buildings to be parallel to the lot lines established on the plot plans. Lots in most subdivisions in the Region create a rectangular plan for lot lines. The narrow end of the lot fronts upon the street (to reduce development costs), and the longer side is perpendicular to the street. However, the actual orientation of the lot lines is generally governed by the street orientation, with little or no concern for its impact upon the solar orientation of buildings or lots. Ten of the Region's 13 municipalities stipulate that, insofar as practical, lot lines are to be perpendicular to the street, or radial to curved streets.

c.1. Recommendation

b.1. Recommendation

The orientation of lot lines should, insofar as practical, be based upon orientation to the sun. This approach will pose no problems on east-west streets or north-south streets. In these two cases the narrow end of the lot will front the street. Developments on north-south streets will encourage houses to be built with their narrow end facing the street while developments on east-west streets will encourage houses to be built with their long end facing the street. The east-west street pattern is most appropriate for low density suburban areas whereas the north-south street pattern is appropriate in both high and low density

residential developments. Either one of these street patterns is compatible with standard approaches for building setback and orientation. However, in those cases where streets run intercardinally (i.e., north-east to south-west), lot orientations should not be determined by the orientation of the street, but by its orientation to the sun. (See Figure on page 38.)

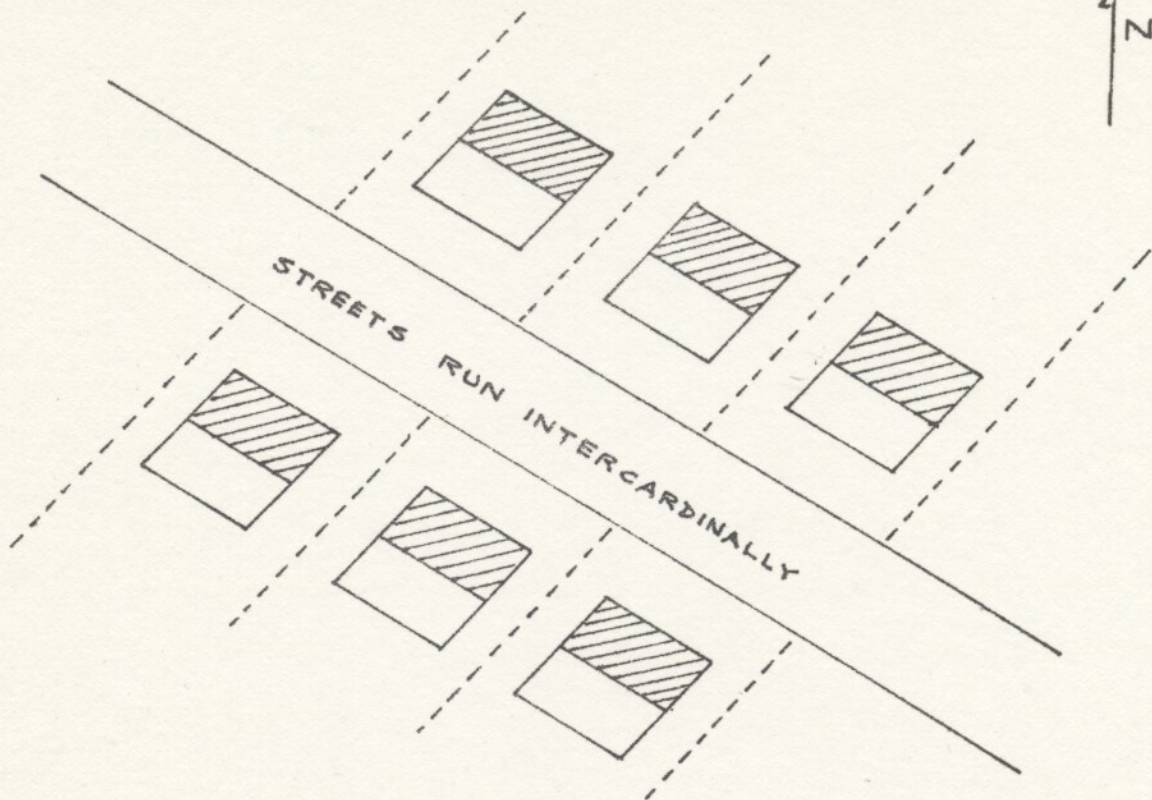
c. Street Orientation

Many of the difficulties in providing for proper building and lot orientation can be surmounted by establishing a neighborhood street plan that encourages traffic to flow in east-west patterns, wherever possible. In the past, the layout of residential streets in the Region has largely been determined by the presence of steep slopes, the depth to bedrock, the location of wetlands, soil conditions, and the alignment of new streets with existing streets. Although street orientations must consider existing street patterns and soil conditions, these factors by themselves do not create any barriers to the construction of east-west oriented streets. In those cases where streets cannot be oriented to promote solar energy systems, lot orientation or building orientation should be flexible to compensate for the barriers of local topographic conditions or existing street patterns.

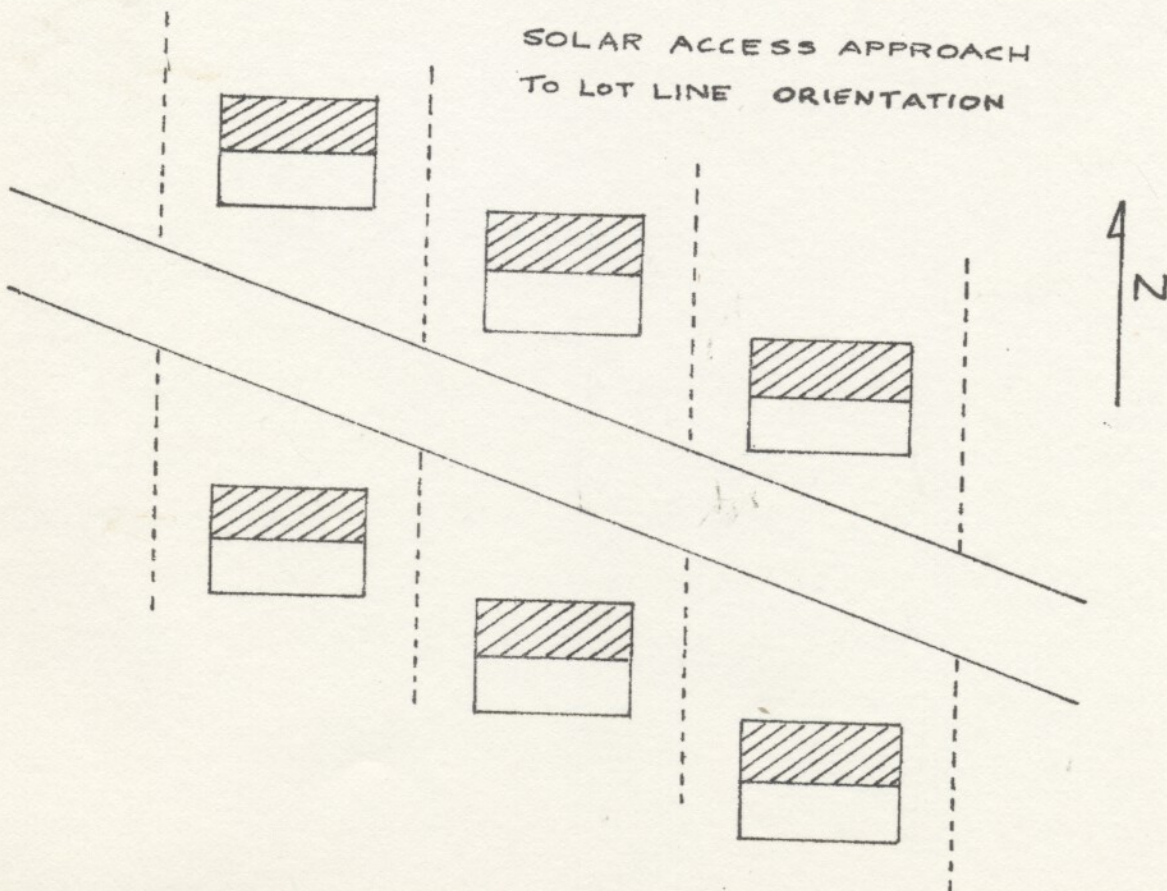
c.1. Recommendation

Street planning and design standards should be revised to encourage the development of east-west streets. However, where local soil conditions and zoning densities dictate alternative orientations to the street, planning commissions should then encourage the development of north-south streets while simultaneously stipulating that lot lines be perpendicular to street lines, and roof pitches be perpendicular with their narrow end facing the street while developments on east-west streets to due south.

TRADITIONAL APPROACH TO LOT LINE ORIENTATION



SOLAR ACCESS APPROACH
TO LOT LINE ORIENTATION



d. Open Space Dedications

The use of open space in subdivisions could play an important role in the protection of solar access and as a means for siting community solar energy systems serving more than one single-family dwelling, or one or more multi-family dwellings. One of the principal advantages of utilizing open space for siting community solar

energy systems is that it can make possible economies of scale allowing for lower per unit costs for the use of solar domestic hot water heating, or solar space heating in each dwelling. Utilization of open space for the siting of solar domestic hot water or solar space heating systems would require that open space locations be specified to minimize the distance between each building lot and the solar energy systems. Currently, the subdivision regulations in the Central Naugatuck Valley Region specify only the minimum amount of land to be dedicated for open space without mentioning, or suggesting, the location of open space or its relationship to building lots. In order for community solar energy systems to be viable concepts, planning commissions could encourage, or require, developers to locate lots as spokes off a central open space to serve as the hub to the neighborhood or to cluster development to achieve higher densities, thereby reducing the heat losses arising from the transfer of heat to its point of use. The use of community solar energy systems would allow for greater flexibility in street layouts, since the solar collector panels would not be affected by lot or building orientations.

Nonetheless, even if a community solar energy system is adopted, proper building orientations are still important in order to maximize the use of passive solar energy concepts, such as south facing windows and clerestories, trombe walls,¹ and other heat storage concepts.

Lack of standards governing the location of open space may also serve to retard the use of solar energy systems in areas where residential districts border industrial or commercial districts. In this case, if standards were developed, open space

could be used to protect solar access by serving as a buffer in higher density.

residential zones abutting industrial or commercial districts. Thus, the planning commission can minimize the potential shading problems that might arise when tall factories, offices or shopping centers are built next door. This is a definite issue, since zone changes are a frequent phenomena in the Central Naugatuck Valley Region.*

d.1. Recommendation

Planning commissions should consider establishing open space dedication standards which specify the location of open space in relationship to planned developments. This approach could revitalize the use of open space and make it a meaningful community resource, much like the town green was for the early New England communities.

Open space dedications for community solar energy systems should be located centrally to as many dwellings as possible. This reduces the cost of installing underground utilities between the solar energy system and each participating dwelling unit.

e. Design of Terrain and Trees

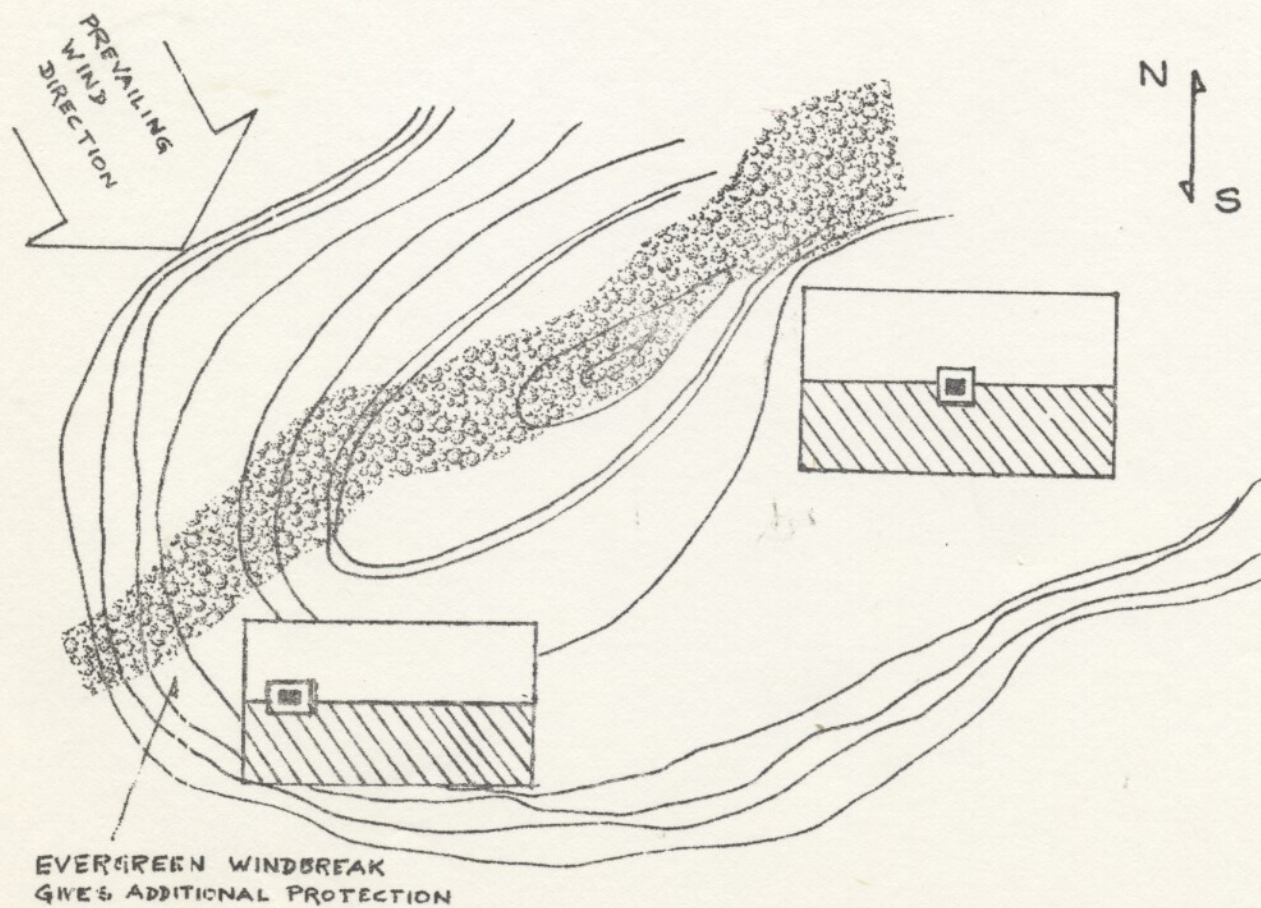
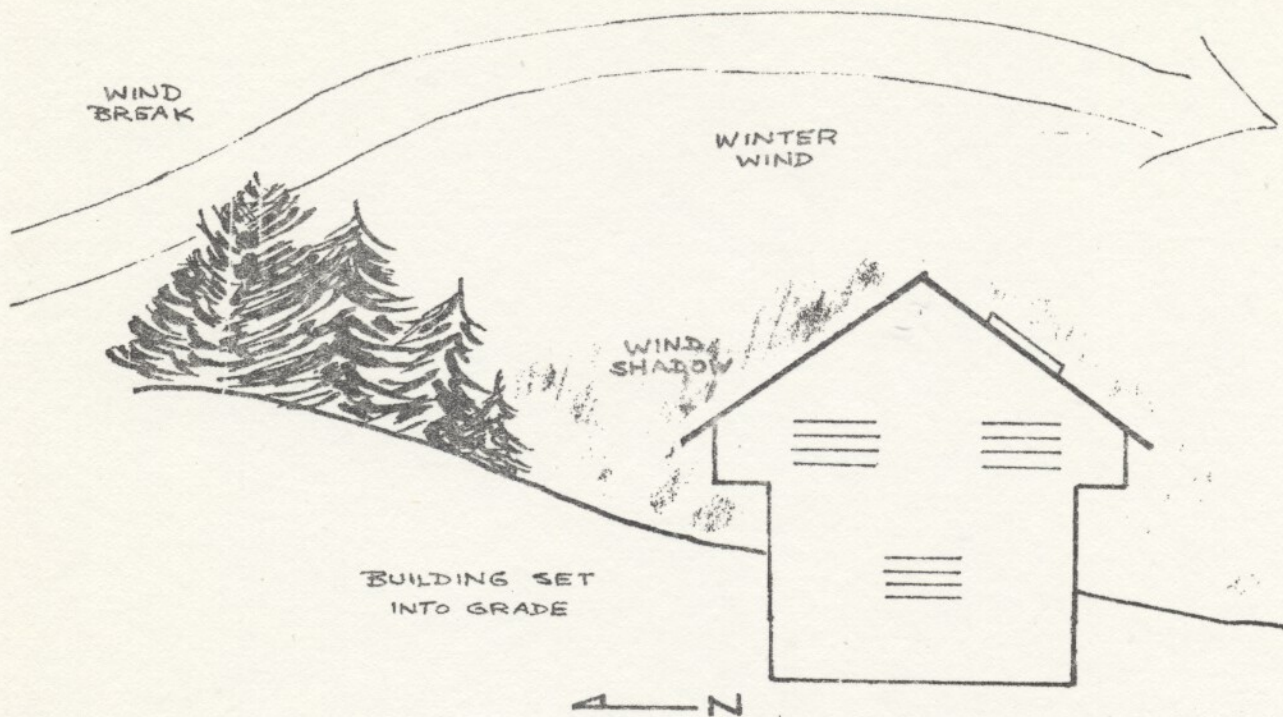
Landscaping with vegetation and earth can help both to reduce the heating requirements of a dwelling, and meet some of these heating requirements as well. Natural features of the environment can often be effectively integrated with the design of a dwelling to minimize chilling north winds in the winter, and to provide natural air conditioning in the summer. Landscaping of building lots, or the use of existing natural features, can be used to provide wind barriers on the northern

*Between 1970 and 1977 there were a total of 19 zone changes in the Region, involving the reclassification of residential land to commercial or industrial uses, or the reclassification of industrial land to residential uses.

side of the house, or to insulate the foundation of a dwelling. Terraces, mounds, fences or trees placed on the north side of the house have been found to be effective wind barriers, diverting wind currents over the roof or around the side of the house. A study² conducted in the midwest found that a wind barrier reduced the heating requirements of one building by 20% compared to an identical house sited and oriented in the same climate without a wind barrier. Energy efficient landscaping is particularly significant as a passive solar design concept when earth mounds or terraces are incorporated into the building's surrounding design. (See figure next page.) In this case, earth sheltering serves as a moderating influence on the heating requirements of the dwelling. This opportunity for energy efficient landscaping is available in all subdivisions, though it is probably easier and less expensive to utilize earth sheltering and natural wind breaks when development occurs in hilly areas, such as south facing slopes. (See figure next page.) A south facing slope offers the hill as a wind break and facilitates the use of earth material for insulation around the foundations of the structure. Based on a review of the Region's subdivision regulations, none of the planning commissions are encouraging the use of landscaping for energy conservation, or for promoting passive solar design concepts.

e.1. Recommendation

Planning commissions should provide incentives to developers to utilize energy efficient landscaping. The incentives could include reducing the cost of development by reducing lot sizes, lot frontages, road widths, house sizes and open space dedication standards. Furthermore, where the north side of the lot fronts upon a public street, a planning commission could require that a hedge or row of low trees be planted to serve as a wind barrier to houses on the south side of the street. Tree species and hedge types which are not in conflict with long-term solar access should be specified. This would entail the use of evergreen shrubs having a maximum height at maturity of 30 feet or less.



f. Densities

Increasing the density of development may be a very useful tool for increasing the potential market for solar energy systems. Contrary to popular opinion, solar energy systems do not require low density residential locations to ensure solar access, or to locate a suitable site for the system. Higher density developments such as multi-family housing, row houses, and planned unit developments have four significant solar energy advantages over the single family detached residential dwelling: (1) higher densities allow for the potential shared use of a solar energy system; (2) higher density developments avoid shading problems among individuals in each dwelling unit, since solar energy systems are normally shared by an entire building; (3) higher density developments often are built with flat roofs which tend to facilitate the installation of solar energy, since building orientation is no longer a barrier; and (4) higher density developments are more energy efficient since they can make use of common walls, zero lot line techniques and smaller minimum floor area requirements than single family detached housing.

Unfortunately, despite the advantages of multi-family housing, only two municipalities in the Region allow multi-family housing as a matter of right (Waterbury and Watertown). An additional seven municipalities allow multi-family housing under a special permit, or a site development plan, but have all too often constrained the advantages of this housing option by establishing (1) bedroom restrictions (Woodbury), (2) placing limitations on the number of dwelling units per structure (Cheshire, Oxford, Wolcott and Woodbury), and (3) by establishing excessive minimum floor area requirements (Oxford). Consequently, the energy efficiencies offered by higher density development have been severely constrained. This, in turn, restricts the use of solar energy systems since it is at higher density development that solar energy is most economical and attractive.

f.1. Recommendation

Planning and zoning commissions should consider permitting multi-family development to occur at substantially greater densities than is currently allowed. This recommendation will require the combined support of the planning and zoning commissions in each municipality. Zoning commissions must first allow higher density multi-family development as a permitted use. Thereafter, planning commissions can encourage higher density multi-family developments which incorporate solar energy and energy-efficient building design by offering incentives to builders in the form of reduced development costs. Higher density development is also possible for single family residential development through the use of clustering. Cluster regulations generally allow developers to increase densities on one portion of the land in exchange for keeping a greater amount of land in open space. The overall effect of this approach is that net densities remain the same but development costs are reduced and energy-efficient patterns of development are established. In addition, planning and zoning commissions can promote energy conservation by eliminating current restrictions on the number of dwelling units allowed per structure, and by reevaluating the minimum standards for floor area in multi-family housing. Higher density development is energy-efficient largely because it optimizes the use of common walls and reduces the floor space required per dwelling unit.

g. Street Grade

The opportunity of siting solar energy systems on south facing slopes is indirectly controlled by subdivision regulations governing the grade of residential streets. By limiting the maximum grade of residential streets, planning commissions may also be restricting development on steep slopes. Nine municipalities in the Region restrict local streets to grades of less than 10%, one restricts local streets to a maximum grade of six percent (Woodbury), and another to eight percent (Middlebury). In certain instances where development on steep slopes is feasible, these street

grade requirements may unnecessarily restrict the use of south facing slopes.

The Waterbury subdivision regulations have compensated for the potential inflexibility of a maximum street grade standard by allowing the planning commission to waive this requirement if it results in excessive hardship for the developer.

Considering the fact that in 1961, 84% of all the vacant land in the Region was in slopes of 10% or more, street grade standards may not only be limiting the development of solar energy systems, but of land development in general.

g.1. Recommendation

Planning commissions should amend their standards for the grade of local streets to allow grades to be increased to 150% of the current standard when the average daily traffic level is less than 250 vehicles per day, and the length of the grade is relatively short. This approach is consistent with the policies of the American Association of State Highway Officials set forth in Geometric Design Guide for Local Roads and Streets,* and will offer greater opportunities for development on steep south facing slopes.

h. Pitch of Roof

Planning commissions exercise no authority over the pitch or orientation of roofs. This is a domain which has not been subject to public regulation and is unlikely to fall within the powers of a planning commission under Connecticut state enabling legislation. Nonetheless, a planning commission could encourage proper orientation and pitch of roofs by providing incentive regulations for developers willing to install solar energy systems in new buildings.

h.1. Recommendation

Since most homeowners prefer to install solar energy systems on their roofs or as part of the design of the building's walls, it is clear that one of the most significant

*American Association of State Highway Officials, Geometric Design Guide for Local Roads and Streets, 1977, p. 6.

means of promoting solar energy is to encourage the proper orientation and pitch of roofs in all new subdivisions. This could be accomplished by adopting incentive regulations which allow developers to reduce minimum lot size, floor area or lot frontage requirements in exchange for orienting roofs within 15 to 20 degrees of true south and pitching the roof at an angle equal to the latitude. In the Central Naugatuck Valley Region, a roof pitch of 42 degrees is optimum for year round use of solar domestic hot water systems. However, if a planning commission wishes to encourage the use of solar collectors for space heating, it is recommended that roof pitch be set at 54 degrees to make optimum use of the low winter sun when space heating requirements are greatest. Since active solar energy systems for space heating are not yet cost effective it is probably premature to encourage roofs to be pitched at an angle of 54 degrees.

i. Standards for Solar Access in Site Plan

The discretionary powers of the planning commission can be used to guide a developer's plans before a subdivision plan is actually submitted. Under the site plan review process, planning commissions often prescribe standards for erosion and sedimentation control, road construction, landscaping and other considerations. This process could easily be extended to cover solar access considerations so that a developer establishes a subdivision plan that minimizes shading of south roofs or south walls.

i.1. Recommendation

Solar access considerations should be incorporated into the site plan review process of subdivision regulations. Developers should be required to protect solar access for rooftops and/or south facing walls by using the following check list of solar access issues when preparing the subdivision plan. This will ensure that due consideration is given to (1) avoid tree shading problems between neighbors, (2) establishing street and lot orientations which maximize solar access for buildings, (3) landscaping plans that are consistent with solar access, (4) evaluating the

influences of topography (slopes and orientation of land) as they affect shadow lengths, (5) increasing the density of development through clustering in those areas on the site where solar access is optimum, and (6) decreasing the density of development where there is insufficient solar access.

j. Use of Solar Hot Water Systems

Planning commissions in Connecticut may require the provision of public utilities in new developments where these services are necessary for the public health and safety. With the passage of Public Act 78-314, Connecticut planning commissions may also encourage the use of solar and other renewable forms of energy much in the same way that other public utilities are encouraged, if not required, when development occurs in certain areas of a municipality.

During 1979, San Diego County and Santa Clara County, California have both passed ordinances requiring that solar domestic hot water systems be installed on all new dwellings subject to (1) the availability of adequate solar access and (2) the lack of alternative lower cost utilities such as natural gas. These two ordinances were passed largely because it was found that in southern California solar domestic hot water systems are already cheaper than electric hot water heaters and will soon be cheaper than natural gas. Of course, a comparison of costs between electric, natural gas and solar hot water heaters depends on a number of factors including (1) solar insolation, (2) the payback period, (3) water consumption standards, (4) desired water temperature, and (5) expected rates of increase in conventional fuels.

The CNVRPA has recently completed an extensive economic and thermal analysis of solar domestic hot water heaters based on Connecticut climatological data and current and projected costs of conventional fuels. In brief, the findings of the study reveal that solar domestic hot water systems are clearly less expensive on a life cost basis than either electric or fuel oil fired hot water heaters.

j.1. Recommendation

Given the enabling legislation in Connecticut, planning commissions should seriously consider encouraging the use of solar domestic hot water systems by providing the developer with incentives in the form of reduced development costs. New enabling legislation may also be needed which allows planning commissions to mandate the use of solar energy systems just as other public utilities such as water or sewer when they are found to be the least expensive approach to hot water heating consistent with protecting the public health and safety of Connecticut residents.

2. Discretionary Powers of the Zoning Commission

Zoning commissions in the Central Naugatuck Valley Region to date have not specifically created any institutional barriers to the development of solar energy systems.

This is attributable to the fact that so far, nearly all solar installations in the Region have been placed on rooftops and on residential structures where special permits and site development plans have not been required. We have discovered that only one solar installation proposal in the Region has come before a planning and zoning commission, and in that case, the commission paid little or no attention to the details of the design or siting of the solar domestic hot water system.

However, it is possible that an unreceptive commission could thwart the installation of solar energy systems in those cases where the development requires a special permit, special exception or site development plan.* The special permit application process is often used by zoning commissions as a means to regulate unusual land uses, which may require more restrictive land use controls and careful site planning.

Typically, the special permit or special exception is used to regulate non-residential uses that may be developed in single family residential zones. In the Central

*Zoning boards of appeals can also administer special permits/exceptions.

Consequently, the following discussion also applies to these boards as well.

Naugatuck Valley Region, this process is used to regulate multi-family dwellings, hospitals, educational institutions, recreation clubs, nursery schools, and some business and industrial uses (see Table 9).

As can be seen in Table 10, 11 of the Region's 12 municipalities with zoning ordinances have special permit regulations specifying that a site plan is required. Furthermore, eight municipalities require the submission of architectural plans, eight indicate that the commission may require greater setbacks from adjoining property, 10 municipalities may require the applicant to install vegetative buffers, or other forms of screening, and eight municipalities may require the applicant to modify the exterior features of any structure to harmonize with the surrounding neighborhood, or to protect property values.

These strong discretionary powers associated with the special permit application could give zoning commissions a great deal of influence over the development of solar energy systems in those buildings subject to the special permit process. At the very least, the special permit process may serve to complicate and delay the process of installing solar energy systems on buildings subject to this process. This potential for delay will certainly be increased if zoning commissions become particularly concerned about the siting of solar energy systems and the aesthetics of these systems.

Based on recent trends in Connecticut land use regulations, it may be only a matter of time before many residential land uses are also subjected to the special permit or site development plan requirements. Partly because of the inadequacies of Euclidean zoning³ as a growth management tool, planning and zoning commissions in Connecticut have taken a greater interest in site specific issues and the control of individual development proposals. Recently, the Woodbury Zoning Commission amended its regulations to require a site development plan for any new non-residential construction in a neighborhood surrounding and including one of the

Table 9: Selected Uses Requiring a Special Permit Application in Municipalities in the Central Naugatuck Valley Region

Regulated Uses	Beacon Falls	Bethlehem	Cheshire	Middlebury	Naugatuck	Oxford	Prospect	Southbury	Thomaston	Waterbury	Watertown	Wolcott	Woodbury
Convalescent Homes													
Multi-Family Dwellings													
Funeral Homes													
Hospitals													
Automobile Service Stations													
Educational Institutions													
Nursery Schools													
Religious Institutions													
Town & Government Buildings													
Public Utility Substations													
Commercial Greenhouse													
Recreation Clubs													
Commercial Kennels, Veterinary Hospitals													
Trailer Parks													
Selected Uses in Business Zones ¹													
Selected Uses in Industrial Zones ¹													

Table 10: Discretionary Powers Available to Zoning Commissions in the Central Naugatuck Valley Region Through the Special Permit or Special Exception Application Procedure: 1979

General Considerations Covered by Special Permit Regulations						
Municipality	Site Plan Required	Architectural Plan Required	Possible Requirement of Greater Setbacks	Possible Requirement of Screening Premises	Possible Modification of Exterior Features of Any Structures to Harmonize with Surrounding Area	Application Defined as Follows
Beacon Falls	Yes	Yes	Yes	Yes	Yes	Special Exception
Bethlehem				No	Zoning Regulations	
Cheshire	Yes	Yes	Yes	Yes	Yes	Special Permit
Middlebury	Yes	Yes	Yes	Yes	Yes	Special Exception
Naugatuck	Yes	Yes	Yes	Yes	Yes	Special Permit
Oxford	Yes	N.S.	Yes	Yes	Yes	Special Exception
Prospect	Yes	Yes	N.S.	Yes	N.S.	Special Zoning Permit
Southbury	Yes	Yes	Yes	Yes	Yes	Special Exception
Thomaston	Yes	N.S.	N.S.	Yes	N.S.	Special Permit
Waterbury	N.S.	N.S.	N.S.	N.S.	N.S.	Conditional Use
Watertown	Yes	Yes	Yes	Yes	Yes	Special Use
Wolcott	Yes	Yes	Yes	Yes	Yes	Special Permit
Woodbury	Yes	N.S.	N.S.	N.S.	N.S.	Special Exceptions

N.S. = not specified

Source: CNVRPA staff work based on the zoning regulations of each municipality, April 1979.

Town's Historic Districts. The purpose of the amendment was to give the zoning commission greater authority to regulate land uses so that it can act almost as a surrogate historic district commission in an area of town falling outside of the official Historic District boundaries.

3. Discretionary Powers of the Historic District Commission

While this zoning amendment should be a powerful means to control the quality of non-residential development in an area surrounding and including one of the historic districts in Woodbury, it could also create some obstacles for anyone wishing to install solar collectors. According to the requirements of Woodbury's Main Street Design District, the Commission "may grant, grant with modifications, grant subject to conditions, or deny a special permit for any use whether or not such use is authorized in this section or any other section of these regulations."

2.1 Recommendation

While the special permit process is a valid tool to control the development of non-residential uses placed in residential zones, it should not be extended to residential development (including the installation of detached ground-mounted solar collectors). However, where it is used, the special permit process could be an effective tool to promote solar energy and for protecting solar access. The special permit application process could stipulate that (1) non-residential buildings should be oriented to the south, (2) use architectural designs and natural features which support the use of solar energy, and (3) make use of landscaping designs compatible with the use of solar energy and protection of solar access. The aesthetic, architectural and landscaping controls available through the special permit process clearly indicates that planning and zoning commissions could use this process to support the development of solar energy systems on new non-residential buildings. Furthermore, the special permit process could influence the design of buildings and solar energy systems by establishing standards for architecturally compatible solar design. Two clear examples of pleasing solar designs can be

seen already in Waterbury and Cheshire, where the Waterbury Police Department building and the Cheshire Hillside Village housing for the elderly have incorporated solar collectors into the designs of their respective roofs.

3. Discretionary Powers of the Historic District Commission

Historic District Commissions have been authorized by state enabling legislation to protect and preserve the historic character of designated areas within a municipality. There are three historic districts in the Region, one in Bethlehem, one in Southbury and the third in Woodbury. Residential structures are subject to the historic district regulations in these three municipalities. While none of these historic districts has yet reviewed an application to install a solar energy system, they are allowed wide latitude by state statute to control the siting, orientation, color, size and shape of solar energy systems.

Potentially, a historic district commission, which was unreceptive to the use of solar energy systems, could modify or disapprove an application for an attached greenhouse, a solar domestic hot water system or a passive solar design requiring the modification of the outer appearance of the rooftop, wall or one of the yards of the historic buildings. Unlike a zoning commission, which generally only regulates land uses, an historic district commission is specifically concerned with the exterior architectural features of buildings, structures and other uses. Consequently, they have wide power to control the development of solar energy systems when these systems result in a modification of the design or appearance of the building. Individuals intending to install solar collectors on a historic building are first required to obtain a certificate of appropriateness from the commission. According to state statute, the certificate will be issued only when the commission has considered "the historical, and architectural value and significance, architectural style, general design, arrangement, texture and material of the architectural features involved, and the relationship thereof to the exterior

architectural style and pertinent features of other structures in the immediate neighborhood."⁴

Depending upon the attitudes of commission members, these guidelines could pose serious barriers to the installation of solar domestic hot water systems on historic homes. As an example, one rooftop domestic solar hot water system has already been disapproved by a historic district commission elsewhere in the state because it was not aesthetically compatible with the building.

However, the Southbury and Woodbury Historic District Commissions appear to be much more open-minded about the future use of solar energy. A roundtable conference held with the Woodbury Historic District Commission on June 12, 1979,⁵ revealed that solar energy systems would be looked at with an open mind, as long as the systems had minimal impact upon the aesthetic appearance of the district as seen from the public way. Collectors located in backyards, backroofs, sideyards (screened from public view), or roofs slanting to the side (rather than toward the road) would not be considered as posing serious threats to the integrity of the historic district. One Commission member emphasized that the Commission was concerned with energy conservation and alternative energies, since part of the mandate of the Historic District Commission is to maintain dwellings as continuously useful and usable structures for its occupants.

The Commission members agreed that any changes made on the interior of the house, such as water walls, or other passive design modifications, would not require Commission approval. The replacement of single glazed windows would require the Commission's approval, but the six members in attendance felt that as long as the "colonial window style" was maintained, double glazed windows would pose no problems.

While "the view from the public way" appears to be the salient criteria used to determine the appropriateness of structural changes to a house, the Commission

members intimated that if solar equipment is properly sited, screened, and designed to minimize its incongruity with the view from Main Street, it would be perfectly acceptable. Nonetheless, they did emphasize that each application would be treated on a case-by-case basis.

3.1 Recommendation

The state enabling legislation for Historic Districts should be amended to establish special standards for the review of passive and active solar energy systems placed on buildings located in historic districts. In determining the appropriateness of solar energy systems on historic buildings, historic district commissions should consider (1) the visibility of the system from the public way, (2) the extent to which the solar energy system maintains the historic building as a continuously useful and usable structure, and (3) the harmony of the system with the design of the building. Furthermore, limited solar access on an historic district property should be considered one of the valid reasons for allowing variances to the strict application of the regulations for determining appropriateness. This will require amending Section 7-147g of the General Statutes of Connecticut to specify that insufficient solar access is a reason for varying the strict application of any provisions used to determine appropriateness (as defined in Sections 7-147a to 7-147k).

Above and beyond enabling legislation supportive of solar energy systems, historic district commissions need to develop familiarity with solar energy systems so that these commissions can play a more active role in guiding developers and owners in the use of aesthetically compatible solar design.

4. Discretionary Powers of the Inland Wetland Agency

Solar collectors may also be subject to the regulations of the Inland Wetland and Watercourses Agency in each municipality. The General Statutes of Connecticut

(Sections 22a-36 to 22a-45) allows municipalities to establish inland wetland boundaries and regulate activities which are within or use a wetland or watercourse. In particular, "regulated activity" has been defined in Section 22a-38 to mean "...any operation within or use of a wetland or water course involving removal or deposition of material, or any obstruction, construction, alteration or pollution, of such wetlands or water courses, but shall not include the specified activities in section 22a-40."⁶

The principal reason an inland wetland agency could become involved in the installation of solar energy systems is (1) to protect water bodies from thermal and toxic pollution, and (2) to protect wetland trees from being cut. The installation of detached solar collectors in a wetland area would almost always involve the cutting of a large number of trees to gain access to the sun. This could create some problems for homeowners in those communities where inland wetland agencies strongly discourage tree cutting in wetland areas. At least one inland wetland agency in the Region has maintained a strong stand against tree cutting in wetland areas.⁷ This policy may create numerous barriers to the development of solar energy systems, particularly since most wetland areas in the Region are forested, and a large portion of the remaining developable land in the Region is classified as wetlands. Inland wetland agencies may also regulate solar energy systems if they incorporate water from waterbodies, streams or wetlands into the operation of the solar energy system, or if they may affect the water quality or water temperature of regulated

water bodies. Although it is unlikely to be a serious issue, it is possible that watercourses or wetlands could be tapped for cooling buildings and used for the disposal of waste heat. The problem of thermal pollution is probably not a major concern but, if solar cooling systems become economical it may become an issue in the future.

be expected to raise the water level in the leaching field. In practice, it is

It is possible, however, that detached ground-mounted solar collector panels would be regulated when located on, or adjacent to, a wetland area. Solar collector panels could threaten water quality if toxic antifreeze liquids are used which might eventually leak into groundwater or surface water supplies. In addition, solar collector panels will undoubtedly be prohibited in all wetland areas which are within the limits of the 100-year flood as defined by the National Flood Insurance Program.

4.1 Recommendation

Solar energy systems should be required to meet the regulations of local inland wetland agencies and the flood plain regulations established by zoning commissions.

5. Discretionary Powers of the Town Sanitarian

a. Septic tank regulations

In some rare instances, an individual installing a solar energy system may be forced to consider the effects of water running off the solar collector panels and into a septic system leaching field. Under Section 19-13-B20n of the Connecticut Public Health Code, the Town Sanitarian has the authority to regulate ground water, roof, cellar, and yard drainage. The Public Health Code states, "No ground water drainage or drainage from roofs, cellars, roads, or yards shall discharge into or within 25 feet of any portion of a subsurface sewage disposal system."⁸

The purpose of this regulation is to insure the proper functioning of the leaching field, since a high groundwater table can cause the leaching field to malfunction. An individual planning to install solar collector panels as a detached structure might be unable to place them in the backyard if (1) the panels are located on top of the leaching field, and (2) if the amount of water runoff from the panels could be expected to raise the water level in the leaching field. In practice, it is

unlikely that solar collectors would be affected by septic tank regulations since most solar collector systems installed in single-family dwellings would probably have insufficient surface area to create serious water runoff problems. Only large multi-family buildings, or commercial and industrial applications using detached solar energy systems, would be likely to have sufficient impervious surface area to merit a review of the solar systems' possible impact on septic system leaching fields.

b. Water well regulations

Detached solar collectors will also have to be kept a safe distance from water wells. Under Section 19-13-B5ld, the Public Health Code requires that wells "...be as far removed from any known or probable source of pollution as the general layout of the premises and the surroundings will permit; and so far as possible, be in a direction away from ground water flow from any existing or possible source of pollution. No such well shall be located within 75 feet of a system for disposal of sewage or other source of pollution..."⁹ Detached solar collector panels may pose a danger to drinking water supplies when toxic antifreeze solutions are used, and when the pipes connecting the panels to the building's hot water system are within 75 feet of a water well. Under these conditions, leaking collector pipes could be a serious health hazard. It is probably reasonable to expect that the state's septic tank and water well regulations will probably have their greatest impact at locations where large solar installations are contemplated, and where there is also insufficient lot area to safely accommodate solar collector panels, a water well and a septic system leaching field. Consequently, it is unlikely that the Town Sanitarian will play a large role in the regulation of solar energy systems or prohibit their installation.

5.1 Recommendation

Current septic tank and water well regulations are necessary to protect the public health and should not be altered. Very few solar energy systems will be affected in any significant way by the Public Health Code. Nonetheless, in those instances where the Public Health Code constrains the development of solar energy systems, it is imperative that these systems conform to the Connecticut health and safety standards established for septic tanks and water wells.

6. Discretionary Powers of the Building Inspector

The State of Connecticut's Basic Building Code¹⁰ has not been a serious barrier to the installation of solar energy systems. This is, in part, due to the fact that some building inspectors do not appear to be knowledgeable enough about solar energy at the present time to inspect the work properly. Interviews with the Region's 13 building inspectors revealed a wide range of inspection practices. At one extreme, building inspectors who were personally knowledgeable about solar collectors stated that they paid special attention to the safety and efficiency of the system. At the other extreme, those who had little or no knowledge or interest, would in some cases issue a building permit apparently without inspecting the units installed. Not surprisingly, without any building code solar energy regulations prior to December 28, 1978 in Connecticut, building inspectors used widely varying standards and guidelines for inspecting solar heating systems. Some inspectors considered numerous problems, including those created by the roof load of collector panels, the possible intermingling of potable water and antifreeze solutions used in domestic hot water systems, zoning issues (setback and accessory use regulations), the adequacy of the storage tank and the adequacy of the backup heating system. In contrast, other inspectors said they did not look for any problems, or have any checklist of concerns, because they didn't know enough about solar heating systems to do a proper review. Inspectors who indicated a lack of knowledge about solar heating systems said they tried to apply the general standards of the Building Code wherever they might be applicable to solar systems.

Another reason why the Basic Building Code has not been a serious barrier is that homeowners and contractors have often installed solar domestic hot water systems without obtaining a building permit. Out of a total of 35 buildings¹¹ identified as utilizing solar energy in the Region, apparently as many as eight have been installed without a building permit. These eight cases involve the retrofit of solar domestic hot water systems on existing residential or commercial buildings.

While the Building Code and the practices of building inspectors have not so far been a barrier to solar energy access, they may become so in the future. Connecticut's Basic Building Code was amended on December 28, 1978 to include Article MCA-14 (see Appendix 1) which provides regulations for solar space heating, space cooling and domestic hot water equipment. The new amendment clearly specifies that all solar energy systems require building permits. Furthermore, it establishes detailed procedures for evaluating the energy contributions of solar space heating and solar domestic hot water systems in order to determine the size of the conventional backup system needed to meet the full space heating or domestic hot water requirements of the dwelling. While this procedure only applies to solar energy systems installed by a contractor, it may discourage the adoption of solar energy since a full backup system is still required, unless it can be shown that a smaller backup system will suffice based on the calculations of a licensed engineer. In effect, by requiring heat loss and heat gain calculations prepared by a licensed engineer, the Building Code has added an additional cost and an additional barrier to the use of solar energy. This, of course, is not to imply that heat loss and heat gain calculations are unnecessary in the process of "sizing" the solar energy system and its backup component. Rather, it is to point out that the Code may not provide sufficient flexibility to determine the need for a backup system or the heating requirements of the occupants.

The second concern raised by the new Code amendments is that some of the building inspectors feel it may be too complex or confusing to administer. Based on inter-

views with the Region's building inspectors, the complexity of Article MCA-14 may lead building inspectors to impose their own rules to simplify the process. Significantly, based on interviews held with the Region's building inspectors in May 1979, there was a strong sense that the complexity of the new Code amendment was encouraging a variety of local approaches to its administration, and a variety of techniques for inspections of solar energy systems.

Those who had actually been able to read the amendments felt that the calculations required by the Code (to determine the efficiency of the solar equipment) were beyond the scope of a building inspector's knowledge. The Code requires that an engineer certify the adequacy of the solar heating system and its backup system in those cases where a building will not have a conventional heating system to meet its full heat load requirements. Several building inspectors indicated that they would have no way of knowing whether the engineer's calculations would be reasonable. Furthermore, one inspector who attempted to review the calculation procedures outlined in the Code, found that the ASHRAE* heat loss and heat gain guidelines required by the new Code amendments were, to him, even more confusing than the Code itself.¹² Several inspectors indicated that they were going to require engineered drawings of all solar energy systems despite the fact that the solar amendments do not require that any drawings be submitted. The engineered drawings would show the precise location of all plumbing and electrical systems in relationship to the building or other structures. Though the new solar Code amendments do not require the submission of any plans or drawings, building inspectors have a broad authority to require such plans and drawings if they feel the information will be useful in their inspection of the equipment and structure.¹³ According to the Woodbury Inspector, 10 building inspectors in Western Connecticut recently met and agreed that they would require engineered drawings for all systems prior to the installation of the units.

*American Society of Heating, Refrigeration and Air Conditioning Engineers.

In effect, their position is that by requiring engineered drawings in the beginning,

the inspector will be able to catch any of the potential problems of the system at an early stage, thereby avoiding costly alterations at the time of inspection.

Another building inspector indicated that he intended to require heat loss calculations for all solar installations, even though the new Code requirements specify

that homeowners who install their own systems are exempt from the submission of any heat loss calculations. He stated that unless homeowners were required to submit calculations before installing their solar collectors, they might not know the value or efficiency of the system. In this sense, he felt the greater latitude given to homeowners in the Code could be counterproductive if the systems they installed were not certified to perform properly.

Only one of the Region's building inspectors interviewed found any problems with the solar equipment installed under the 1978 Building Code. The inspector who cited a problem indicated that the pipes used in a homeowner-installed domestic hot water system were too small and had to be replaced. While the remaining solar installations were approved without modification, it is still too early to know whether solar installers are doing a competent job, or whether building inspectors are sufficiently conversant with the operation of solar systems to identify all of the possible problems.

In summary, the Building Code has not posed any real barriers to the installation of solar collectors in the Central Naugatuck Valley Region. However, there appear to be some potential barriers created by the new solar amendments to the Code.

Many inspectors may require added administrative steps and added costs for engineering plans, drawings and heat loss calculations to verify the safety, efficiency and integrity of the system.

6.1 Recommendation

the inspector will be able to catch any of the potential problems of the system at an early stage, thereby avoiding costly alterations at the time of inspection. There is a need for comprehensive training and assistance of building inspectors concerning the mechanics and operation of solar energy systems and the administration of the Building Code amendments. This could be best accomplished at the state level by the State Building Inspector's office, or the Office of Policy and Management. In addition, Article MCA-14 appears to be unnecessarily complex for most building inspectors, and should be revised. In particular, the Code should include simple, easy-to-read procedures for performing the heat loss and heat gain calculations, so that a building inspector or homeowner could perform the calculations without consulting the ASHRAE handbook or a certified engineer. This could encourage homeowners to use heat loss and heat gain calculations on their own.

Only one of the Region's building inspectors interviewed found any problems with the solar equipment installed under the 1978 Building Code. The inspector who cited a problem indicated that the pipes used in a homeowner-installed domestic hot water system were too small and had to be replaced. While the remaining solar installations were approved without modification, it is still too early to know whether solar installers are doing a competent job, or whether building inspectors are sufficiently conversant with the operation of solar systems to identify all of the possible problems.

In summary, the Building Code has not posed any real barriers to the installation of solar collectors in the Central-Northwest Valley Region. However, there appear to be some potential barriers created by the new solar amendments to the Code. Many inspectors may require added administrative steps and added costs for engineering plans, drawings and heat loss calculations to verify the safety, efficiency and integrity of the system.

C. Legal Barriers to Solar Access

Sunlight is the necessary ingredient for all solar energy systems. It must be available during the major portion of each day for a solar collector to function properly. This may not always be possible at every site, due to a variety of man-made or natural objects which stand in the way.

Trees and buildings are the most common causes of shading, although the landscape itself (hills, and terraces) and fences may also pose problems under certain circumstances. These problems can be avoided to a large extent by the proper siting of collectors based on an analysis of the daily and seasonal changes in the angle of the sun as it traverses the sky.

In addition to an analysis of sun angles, an installer of solar collectors must also consider the potential shading problems that may emerge in the future if buildings are allowed to meet the maximum height limitations of zoning, and are placed the minimum allowable distance from the property line. Furthermore, future shading may also be caused by the growth of trees in areas near solar collectors. Consequently, in order to ensure solar access, planners and installers must evaluate (1) existing shading problems, (2) potential shading problems that may emerge under the sanctions of zoning, and (3) potential shading problems that may arise from uncontrolled tree growth. Each of these topics are discussed in detail in this Chapter.

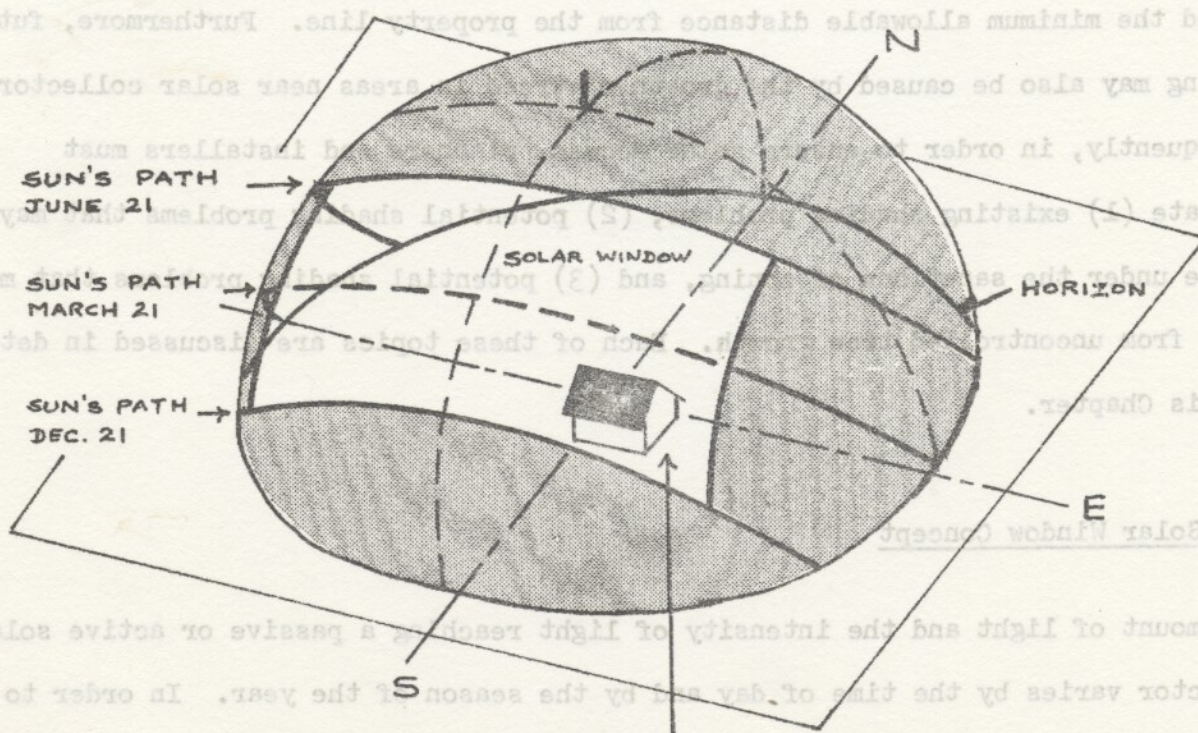
1. Solar Window Concept

The amount of light and the intensity of light reaching a passive or active solar collector varies by the time of day and by the season of the year. In order to ensure that sunlight is available during the hours of maximum sunlight (roughly from 9:00 a.m. to 3:00 p.m.), and during every day of the year, the sun's path can be projected onto a device known as a solar dome (see Figure next page) to determine

if any objects will create shading problems for the collectors between the period when the sun is at its lowest point (December 21st), and when it is at its highest point (June 21st) in the sky. Almost all the useful sun that reaches the solar collectors must come through the "solar window," except for the added effect of diffuse radiation. Any objects which intrude into the solar window will cause a shadow on the collector and reduce the efficiency of the system.

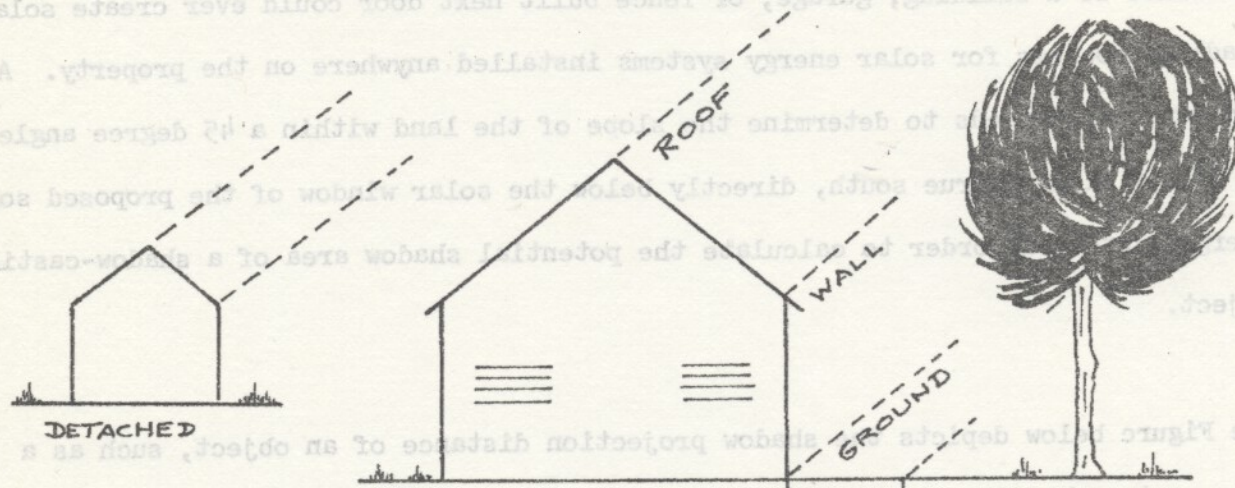
The solar window concept allows a homeowner to determine the potential shade problems on his/her lot prior to the installation of the passive or active solar energy system. As a planning tool, the solar window outlines the three dimensional space which must be protected to ensure the permanent functioning of the solar collection system.

The actual location and size of the solar window will depend upon the type, location and size of the solar energy system installed. As a rule, most solar domestic hot water systems are placed on rooftops, while passive solar collection systems (such as south facing glass windows) are more often found along south walls.



HOUSE WITH SOLAR COLLECTOR

As can be seen in the Figure below, protection of the skyscape for a wall or ground-mounted solar energy system may be more difficult because these locations have a greater potential for shading problems than a rooftop location.



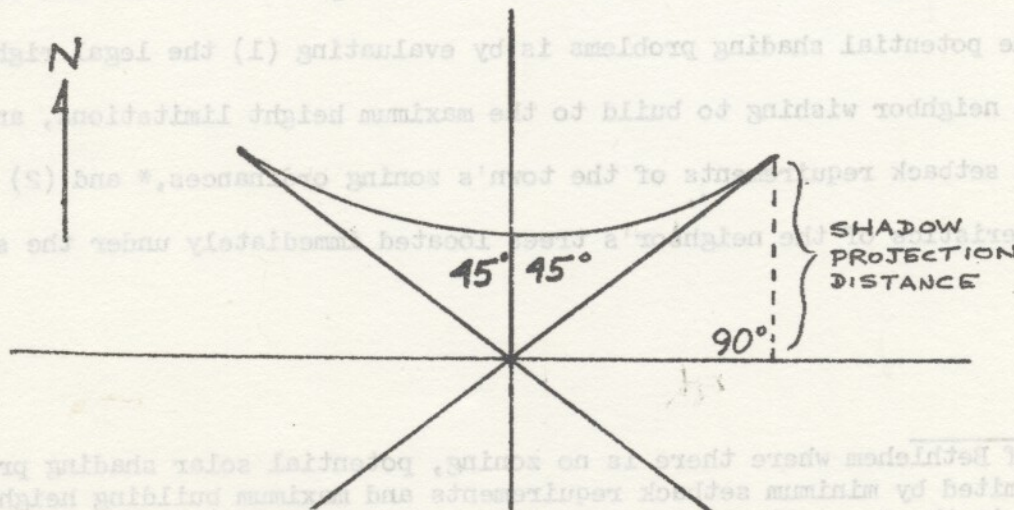
2. Potential Solar Shading Problems: Zoning

Potential solar shading problems are not simply limited to obstructions which are already in place. Trees grow, and neighbors can build buildings or structures which may cast shadows over solar collectors at a later point in time. One way of determining the potential shading problems is by evaluating (1) the legal rights available to a neighbor wishing to build to the maximum height limitations, and to the minimum setback requirements of the town's zoning ordinances,* and (2) the growth characteristics of the neighbor's trees located immediately under the solar window.

*In the case of Bethlehem where there is no zoning, potential solar shading problems are only limited by minimum setback requirements and maximum building heights established in the Connecticut Basic Building Code. Unfortunately the Building Code standards allow for closer spacing of buildings than is normally allowed by most municipalities which have adopted zoning ordinances. Consequently, for the purposes of protecting solar access it is advisable to adopt zoning regulations which establish solar conscious minimum setback standards and building height limitations.

Individuals owning property next to an undeveloped vacant lot, or a developed lot where further development is possible, should determine the potential development opportunities available to one's neighbor before installing a solar energy system. A review of the town's zoning ordinance provides the basic information needed to determine if a building, garage, or fence built next door could ever create solar shading problems for solar energy systems installed anywhere on the property. A homeowner also needs to determine the slope of the land within a 45 degree angle* on either side of true south, directly below the solar window of the proposed solar energy system, in order to calculate the potential shadow area of a shadow-casting object.

The Figure below depicts the shadow projection distance of an object, such as a pole, using shadow patterns falling within 45 degrees on either side of true south. The shadow projection distance is a useful tool for estimating the minimum setback necessary to ensure solar access. Shadow projections are shortest for south facing slopes, and longest on north facing slopes.



*A 45 degree angle on either side of true south delineates the area south of the solar collectors which must be protected from shadows to ensure full sunlight from the early morning (roughly 9:00 a.m.) to the late afternoon (roughly 3:00 p.m.) hours of the day.

As can be seen in Table 11, at 41 degrees 30 minutes north latitude, (Central Naugatuck Valley Region), the length of a shadow is about 16 times as long as the shadow-casting object for north projections (December 21st) on north slopes of 20%. In contrast, the length of a shadow is only about twice as long as the shadow-casting object for north projections (December 21st) on south slopes of 20%. For example, this would mean that a 10 foot fence on a north facing slope of 20% would cast a 160 foot shadow on December 21st during the morning and afternoon hours of the day. In contrast, a 10 foot fence on a south slope of 20% would only cast a 21 foot shadow on December 21st. The extreme difference in the length of shadows on north and south slopes underscores the importance of discouraging the development of building lots and subdivisions on north facing hills, especially when slopes exceed 15%. In the future, planning and zoning commissions may wish to discourage development on north facing slopes since these areas have poor prospects for solar energy systems and because these areas contribute to the heating bills of residences due to greater exposure to winter winds.

Table 11

		Ratio of North Projection of Shadow Length to Height of Shadow Casting Object										
South Slope		20%	15%	10%	5%	Flat	5%	10%	15%	20%	North Slope	
LATITUDE	25°	1.2	1.2	1.3	1.4	1.5	1.6	1.8	2.0	2.2		
	30°	1.3	1.4	1.6	1.7	1.8	2.1	2.4	2.6	3.1		
	35°	1.7	1.8	2.0	2.3	2.5	3.0	3.4	4.1	5.2		
	40°	2.1	2.3	2.6	3.0	3.5	4.2	5.4	7.4	12.6		
	45°	2.3	2.6	2.9	3.5	4.2	5.3	7.2	11.1	25.2		
	48°	2.6	3.0	3.5	6.3	5.4	7.4	11.8	28.6	-		
41° 30'		2.16	2.39	2.69	3.15	3.71	4.53	5.94	8.51	16.38		

Source: Protecting Solar Access for Residential Development: A Guidebook for Planning Officials, p.34, and CNVRPA staff work, July 1979.

The principal zoning provisions which have the greatest impact upon solar shading are those that control the height and the spacing of buildings and other structures.

In the Central Naugatuck Valley Region, these provisions include setback requirements for front, side and rear yards, building height limitations, exceptions to maximum height of structures, projections into required yard areas, maximum height of fences and other similar structures, accessory building regulations, street tree requirements, and non-conforming use regulations.

Building height and building spacing can also be influenced by the policies and actions of the zoning board of appeals and the zoning commission. In Connecticut, zoning ordinances are often varied on a routine basis by the zoning boards of appeal where property owners claim hardship as a result of the strict application of the provisions in zoning ordinances. Similarly, zoning commissions routinely amend the provisions of their zoning ordinance when old regulations prove too inflexible or inappropriate for regulating new developments, or managing the pattern, intensity and timing of new growth.

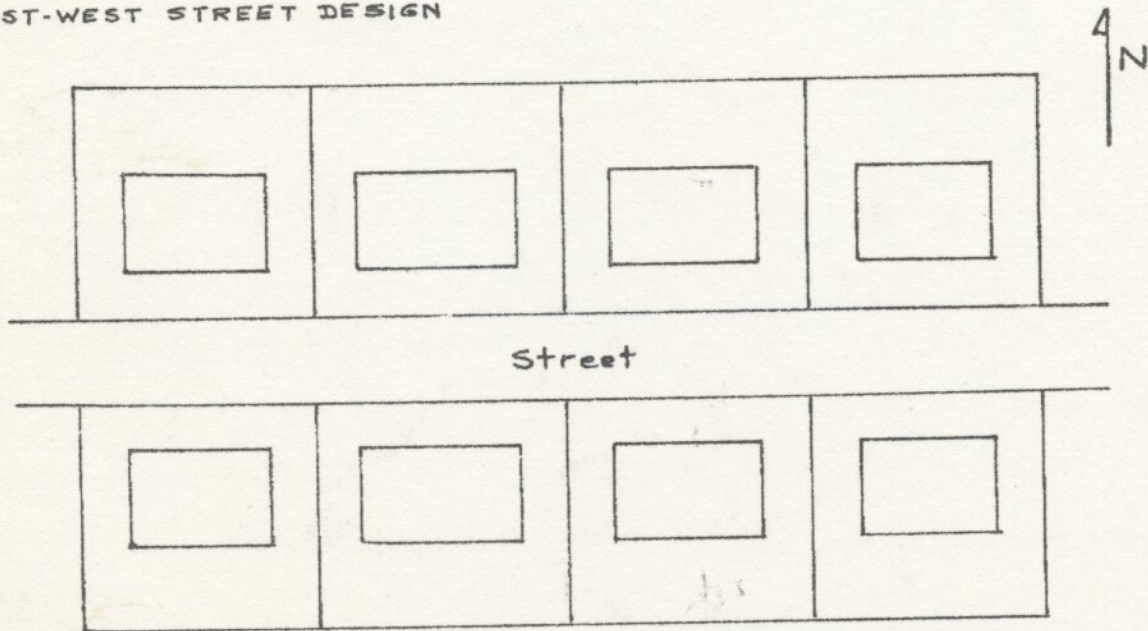
The zoning commission's ability to amend its regulations, and the zoning board of appeal's ability to vary the strict application of the zoning ordinance, clearly indicates that zoning regulations are not a permanent safeguard to solar access. This does not imply that zoning ordinances are subject to constant change with respect to building height and building spacing provisions. Rather, it merely emphasizes that zoning is an approach to land use planning which is from time-to-time subject to political and other community influences, and the changing needs of residents within a municipality. This sensitivity to change is one of the features of a zoning ordinance, which makes it a better vehicle for establishing and safeguarding solar access than other land use regulations, such as the state's Basic Building Code.

Source: Protecting Solar Access for Residential Development: A Guidebook for Planning Officials, p. 34, and CNUA staff work, July 1979.

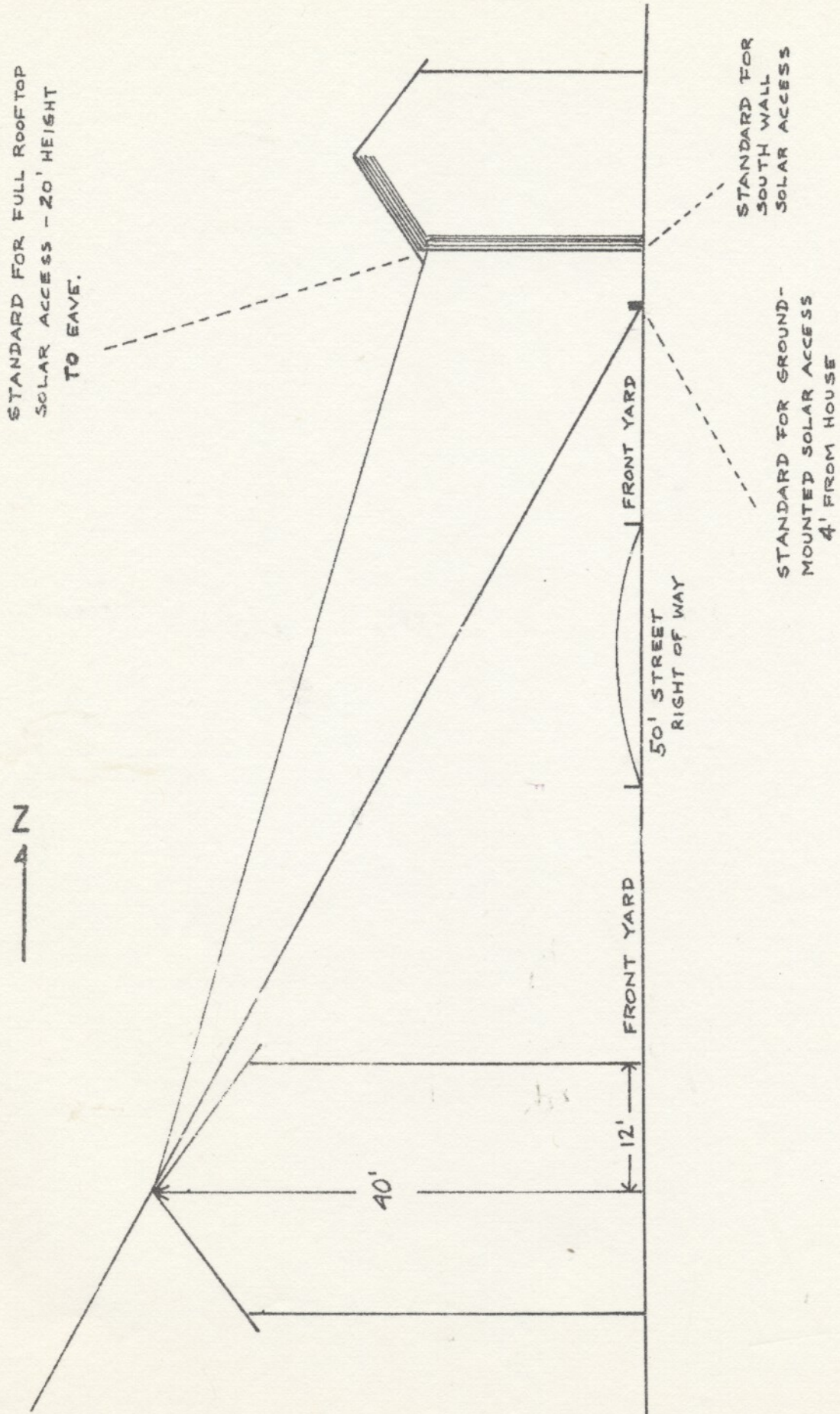
2.1 Shading on East-West Streets

In order to determine the potential shading problems attributable to zoning, the CNVRPA evaluated the potential shadow lengths created by buildings built to minimum front yard setbacks, and to the maximum allowable height in each municipality. For purposes of analysis, it was assumed that buildings could be located on east-west streets, with the roofs of buildings facing north and south, and with houses built on both sides of the street. This approach produces a test of the degree of protection offered by minimum front yard and street right-of-ways standards when buildings on the south side of the street are allowed to reach the maximum specified in the zoning ordinance. The Figure below provides a plan view of the subdivision, and the Figure on the next page provides a profile of the subdivision.

EAST-WEST STREET DESIGN



The analysis was based on three hypothetical situations involving subdivisions on (1) flatland, (2) on south facing slopes of 15%, and (3) on north facing slopes of 15%. This approach provided a more realistic evaluation of potential solar access problems, since the Central Naugatuck Valley Region is hilly and has a great deal of its vacant land in slopes of 10% or more. According to the Land



Recommended Thresholds for Protecting South wall, rooftop and Ground Solar Access

Slope Report prepared by the CNVRPA in 1961, 84% of all the vacant land in the Region was in slopes of 10% or more. Significantly, as can be seen in Table 12, nearly 60% of the Region's vacant land was in slopes of 10 to 15%. The fact that a large portion of the Region's vacant land was (and still is) in slopes of 10 to 15% strengthens the case for using slopes of 15% as a realistic test of future solar shading problems in the Region.

Table 12: Vacant Land by Slope in the Central Naugatuck Valley Region: 1961

Slope	Acres	Percent
0 to 10%	23,144.6	16.0
10 to 15%	84,411.3	58.3
15 to 20%	22,116.2	15.2
20% or more	14,900.5	10.3
Total	144,572.6	100.0

Source: CNVRPA Land Slope Report, Appendix D, June 1961.

This study has established three standards for solar access corresponding to solar energy systems placed on rooftops, solar energy systems utilizing south facing walls, and solar energy systems mounted on the ground. Municipalities choosing to encourage solar energy systems may adopt any one of these standards as the basis for evaluating the impact of their current regulations on solar access. Naturally, the most restrictive standard will be for ground mounted solar energy systems, and the least restrictive will be for solar energy systems located on rooftops. As can be seen on the Figure on page 72, the solar access standard for ground mounted solar energy systems is four feet from the house, the standard for south wall solar access is the edge of the house at the ground, and the standard for rooftop solar access is 20 feet from the ground at the eave of the roof.

Case 1: Flatland

In our hypothetical example, the most significant shading problems attributable to buildings on flatland are those involving the shading of the front yard and the south wall of the house. Appendix 2A indicates that four municipalities (Cheshire, Naugatuck, Oxford and Waterbury) have minimum front yard setback requirements, which are insufficient to guarantee solar access on the south wall of the house when houses across the street are built to the maximum allowable building height. In addition, three municipalities (Beacon Falls, Southbury and Watertown) have at least one or more residential districts in which minimum front yard setback requirements provide insufficient separation between houses on opposite sides of the street to guarantee south wall solar access.

In five municipalities (Cheshire, Middlebury, Naugatuck, Oxford and Waterbury), minimum front yard setback requirements are insufficient to guarantee solar access for ground-mounted collector panels located within four feet of the front yard house line. It is also conceivable that solar shading problems may exist in the three municipalities which provide sufficient front yard setbacks. Topographic conditions, aesthetic considerations, and tree shading problems may dictate the need for greater flexibility in the siting of the collector panels in locations further than four feet from the house.

In contrast, minimum standards for front yard setback in each municipality are sufficient to guarantee full rooftop solar access on flatland for the typical house size (28 feet high) being built today.

Case 2: South Slope of 15%

South facing slopes are the ideal location for solar energy systems due to their greater exposure to the sun and minimal solar shading problems. Appendix 2B indicates that development occurring on the opposite side of an east-west street,

having a south facing slope of 15%, will not block solar access for south walls, front yards (within four feet of the house) and rooftops. The only possible exceptions might be the installation of solar collector panels in the front yard of the medium density residential (RM) zone in Waterbury. The minimum front yard setback in the RM zone is 15 feet, which is only one-tenth of a foot more than the shadow cast by the maximum allowable building located across the street.

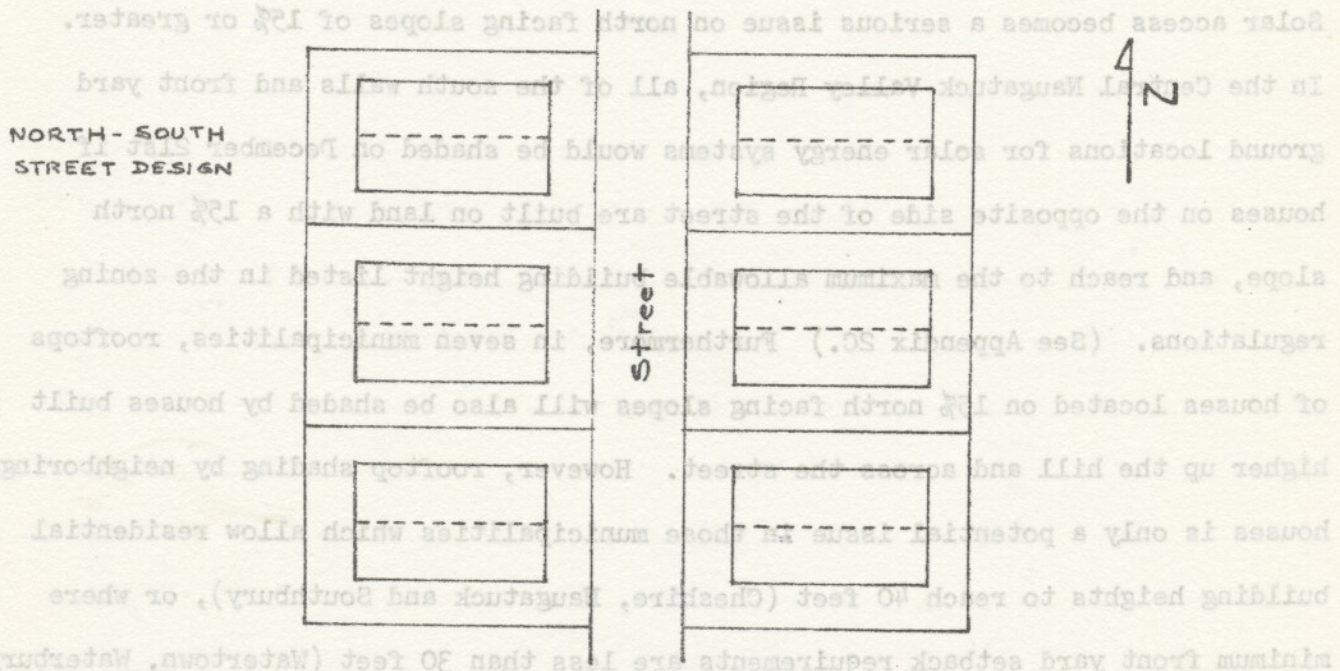
Case 3: North Slope of 15%

Solar access becomes a serious issue on north facing slopes of 15% or greater. In the Central Naugatuck Valley Region, all of the south walls and front yard ground locations for solar energy systems would be shaded on December 21st if houses on the opposite side of the street are built on land with a 15% north slope, and reach to the maximum allowable building height listed in the zoning regulations. (See Appendix 2C.) Furthermore, in seven municipalities, rooftops of houses located on 15% north facing slopes will also be shaded by houses built higher up the hill and across the street. However, rooftop shading by neighboring houses is only a potential issue in those municipalities which allow residential building heights to reach 40 feet (Cheshire, Naugatuck and Southbury), or where minimum front yard setback requirements are less than 30 feet (Watertown, Waterbury, and Beacon Falls). Rooftop shading due to tall residential buildings is not likely to occur very often, largely because few houses are currently being built to the maximum allowable building height, and because houses are often set back further from the street than the minimum required by zoning.

2.2 Shading on north-south streets

The problems of solar access are considerably different for buildings fronting on north-south streets. In this case, there is no street right-of-way between buildings, and there are usually less restrictive setback requirements for side yards than for front yards. Minimum side yard standards in the Region allow for

residential buildings to be spaced as close as 12 feet apart (6 foot side yard), and as far as 80 feet apart (40 foot side yard). If we assume that a new subdivision is built on a north-south street with the roofs of houses oriented to the south, minimum side yard setback requirements offer the only basis for protection from shading caused by a neighbor's house. The figure below illustrates the plan view of the subdivision.



Case 1: Flatland

In our hypothetical example, the most significant shading problems attributable to buildings on north-south streets are those involving the shading of the south yard and the south wall of the house. None of the Region's municipalities have minimum side yard setback requirements sufficient to guarantee solar access for south yards and south walls when a neighbor's house is built to the maximum height limitations of the town's zoning ordinance.

Furthermore, minimum side yard setbacks are insufficient to guarantee full rooftop

solar access in two municipalities (Waterbury and Naugatuck), regardless of the residential zone in which the hypothetical subdivision is constructed. An additional five municipalities (Beacon Falls, Cheshire, Middlebury, Southbury and Watertown) have zoned portions of their town for minimum side yard setbacks which are insufficient to guarantee full rooftop solar access. Only the municipalities of Oxford, Prospect, Wolcott and Woodbury provide sufficient side yard setbacks to ensure full rooftop solar access for a residential building with a

minimum height to the eave of 20 feet.

Case 2: South Slope of 15%

When residential developments are on slopes of 15% facing to the south, solar access is improved considerably. However, the minimum side yard setbacks adopted by 10 of the Region's municipalities are still insufficient to guarantee solar access for south yards and south walls within any of their residential zones. Only the municipality of Wolcott, and the 2 acre zone in Middlebury, have sufficient side yard setbacks to guarantee south wall solar access under the "worst case" conditions associated with building lots fronting on a north-south street.

Significantly, south facing slopes of 15% do provide sufficient clearance from buildings to the south to guarantee full rooftop solar access in eight of the municipalities in the Central Naugatuck Valley Region. In the case of Cheshire, Naugatuck, Southbury and Waterbury, there may be a potential for shading of rooftops in their high density residential zones which have minimum lot sizes of 20,000 square feet or less.

Case 3: North Slope of 15%

Solar access for south yards or south walls is not possible anywhere in the Region when our hypothetical development is built on north facing slopes of 15%. In addition, minimum setback requirements are insufficient to guarantee full rooftop solar access in virtually every residential zone in the Region. Only the low density residential zone in Wolcott (minimum lot sizes of 60,000 square feet) has barely sufficient side yard spacing to avoid rooftop shadows.

The protection offered by the Wolcott zoning ordinance reflects the adoption of minimal building height standards and greater than average setback requirements, (compared to similar density categories elsewhere in the Region).

2.3 Recommendation

One potential opportunity open to planning and zoning commissions wishing to protect solar access and to conserve energy, would be to reevaluate minimum lot size, frontage, setbacks and building height requirements in relationship to the slope of the land. This approach could be used to ensure that buildings constructed in every area of a municipality have the necessary access to the sun.

In areas of steep north facing slopes, zoning commissions could require larger lot sizes, smaller lot frontages and greater setbacks to compensate for the greater length of shadow-casting objects. Similarly, in areas of steep south facing slopes, smaller lot sizes could be provided to maximize the opportunities for the future installation or retrofitting of solar energy systems.

Zoning for solar access could be accomplished in two alternative ways. One approach could be to identify all areas of the municipality, which are best suited for solar energy systems, based on a detailed review of soil conditions, land slopes, slope orientations, as well as all other planning considerations

(e.g., water supply, sewer services, proximity to urban services, etc.). Solar access zones could then be delineated on the zoning map, with special standards established for maximum height of buildings, minimum setbacks and lot frontages.¹ Different setback standards could also be established for neighborhood streets following a north-south axis, and for those following an east-west axis. This would allow developers greater flexibility in the street design chosen for the subdivision.

The map on the following page provides an idea of what a solar access zone might look like if it were established in Woodbury. The map identifies slopes with southerly orientation and could be used as an overlay to the existing Woodbury zoning map. New zoning standards might be established in the unshaded areas since solar access might not be protected under current standards. In contrast, in shaded areas, current standards for height and setback would probably be sufficient to protect solar access. The one disadvantage to this approach is that it requires a lengthy analysis of land slopes and orientations to prepare the solar overlay map and may require the revision of the town zoning map. Consequently, unless the town has a town planner, it may be a burdensome approach.

The second approach to protecting solar access is to develop solar access overlay zone regulations. Unlike a delineated solar access district, an overlay zone regulation for solar access could be approved anywhere in town, subject to the review and approval of the zoning commission. The advantage of this approach is that the developer would be responsible for identifying the potential location best suited for solar energy. If attractive incentives were provided to the developer in the form of reduced development costs in new subdivisions and expedited processing of subdivision applications and other map requirements, an overlay zone regulation could be an effective device to promote solar energy and encourage development in those areas where solar access is least vulnerable to shadow-casting objects.

POTENTIAL SOLAR ACCESS ZONES IN WOODBURY, CT



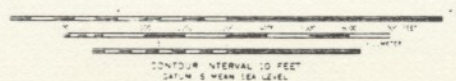
Based on orientation of slopes
falling between 22.5° S of True East
to 22.5° S of True West



★
 MN GN
 13° 1°12'
 231 MILS 21 MILS

UTM GRID AND 1970 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Source: CNVRPA staff work based on the U.S. Geological Survey Maps for
Woodbury, CT, January 1980.



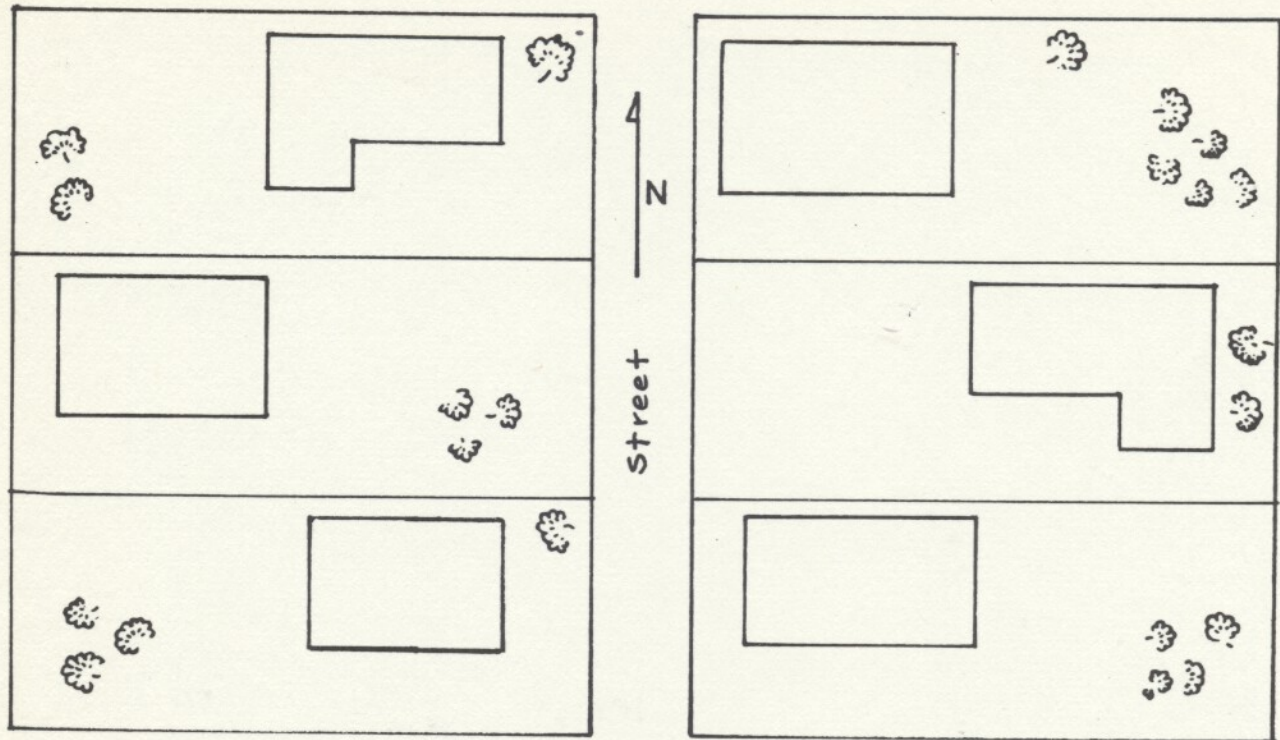
3. Setback requirements

Clearly, side yards and front yard setbacks are insufficient to guarantee solar access under the two hypothetical street configurations discussed above (see Tables 13, 14, and 15). Solar access can be protected by increasing setback requirements to avoid rooftop, south wall and ground locations for solar collector panels. However, this approach will inevitably increase minimum frontage and lot size requirements, which would in turn tend to increase the cost of housing. The cost of land improvements is directly related to minimum frontage requirements, and the cost of housing is closely related to the size of the lot. Consequently, increasing minimum setback requirements could very well be counterproductive.

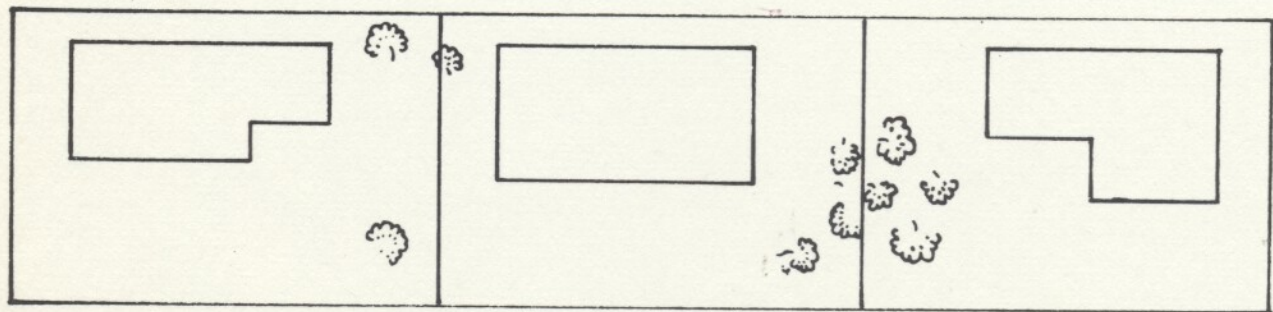
3.1 Recommendation

The problems posed by setback requirements can be circumvented to a large degree if solar access is planned on a neighborhood rather than on a lot basis. At a neighborhood level, shading caused by buildings can be avoided by establishing variable frontyard setbacks for new subdivisions. On north-south streets, every other building could be located further back than the minimum front yard setback in order to reduce shading caused by neighboring buildings. (See Figure on page 82.) Similarly, on east-west streets, buildings on the north side of the street could be setback as far to the north as possible, so that most objects casting shadows would be on the owner's property and subject to pruning.

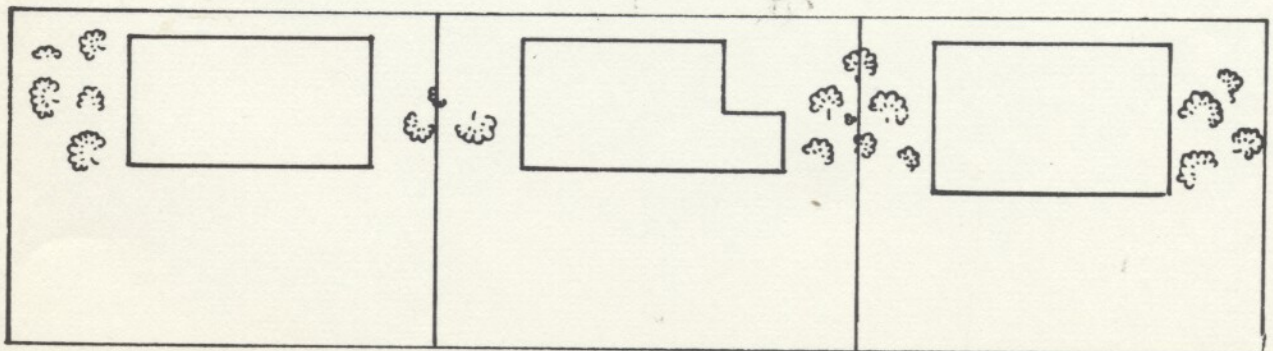
TWO APPROACHES TO VARYING SETBACKS FOR SOLAR ACCESS



Allows for maximum use of passive solar design concepts



Street



Allows for maximum control of tree shading by property owner

Table 13: Front Yard Setback Requirements by Lot Size for Single Family Dwellings within Residential Zones of the Central Naugatuck Valley

Municipality	Under 10,000 Square Feet	10,000 to 19,999 Square Feet	20,000 to 39,999 Square Feet	40,000 to 59,999 Square Feet	60,000 to 79,999 Square Feet	80,000 Square Feet and Over
Beacon Falls	25	25/35 ¹	25/35/40 ¹	25/35/40 ¹	40	
Bethlehem	----- No Zoning Regulations -----					
Cheshire	-	-	40	40	-	40
Middlebury	-	-	35	35	-	35
Naugatuck	25	30	40	-	-	-
Oxford	-	-	-	-	30	-
Prospect	-	-	-	50	-	50
Southbury	-	-	30/40 ²	50	50	50
Thomaston ³	-	-	50	50	-	-
Waterbury	25/20/15 ⁴	-	-	-	-	-
Watertown	25	35	35	-	50	50
Wolcott	-	-	40	40	40	-
Woodbury	-	-	-	50	50	50

¹ R3 = 25 feet R2 = 35 feet R1 = 40 feet

² R20 = 30 feet R30, R30A = 40 feet

³ Minimum required front yard may be reduced in substantially built up areas.

⁴ RL = 20 feet RM = 15 feet RS = 25 feet

Source: CNVRPA staff work based on the zoning regulations of each municipality, April 1979.

Table 14: Side Yard Setback Requirements by Lot Size
for Single Family Dwellings within Residential
Zones of the Central Naugatuck Valley Region

Municipality	Under 10,000 Square Feet	10,000 to 19,999 Square Feet	20,000 to 39,999 Square Feet	40,000 to 59,999 Square Feet	60,000 to 79,999 Square Feet	80,000 Square Feet and Over
Beacon Falls	10	15/17.5 ¹	10/15/ 17.5/25 ¹	10/15/ 17.5/25 ¹	25	-
Bethlehem	----- No Zoning Regulations -----					
Cheshire	-	-	12	30	-	40
Middlebury	-	-	15	25	-	40
Naugatuck	10	15	20	-	-	-
Oxford	-	-	-	-	25	-
Prospect	-	-	-	25	-	25
Southbury	-	-	15/20 ²	25	30	30
Thomaston	-	-	15	15	-	-
Waterbury	10/6 ³	-	-	-	-	-
Watertown	10	10	20	-	25	25
Wolcott	-	-	-	30/35 ⁴	35	-
Woodbury	-	-	-	20	30	30/40 ⁵

¹R4 = 10 feet R3 = 15 feet R2 = 17.5 feet R1 = 25 feet

²R20 = 15 feet R30 = 20 feet

³RL, RM = 6 feet RS = 10 feet

⁴R40 = 30 feet R50 = 35 feet

⁵OS80 = 30 feet OS100 = 40 feet

Source: CNVRPA staff work based on zoning regulations of each municipality,
May 1979.

Table 15: Rear Yard Setback Requirements by Lot Size for
Single Family Dwellings within Residential Zones
of the Central Naugatuck Valley Region

Municipality	Under 10,000 Square Feet	10,000 to 19,999 Square Feet	20,000 to 39,999 Square Feet	40,000 to 59,999 Square Feet	60,000 to 79,999 Square Feet	80,000 Square Feet and Over
Beacon Falls	20	20	20	20	20	-
Bethlehem	----- No Zoning Regulations -----					
Cheshire	-	-	30	40	-	40
Middlebury	-	-	15	25	-	40
Naugatuck	30	20/25/30 ¹	30	-	-	-
Oxford	-	-	-	-	25	-
Prospect	-	-	-	50	-	50
Southbury	-	-	15/20 ²	25	30	30
Thomaston	-	-	50	50	-	-
Waterbury	25	-	-	-	-	-
Watertown	30	30/25 ³	50	-	50	50
Wolcott	-	-	30	40	40	-
Woodbury	-	-	-	50	50	50

¹R01 = 10 feet RA1, RA2 = 25 feet RL5 = 30 feet

²R20 = 15 feet R30, R30A = 20 feet

³R10 = 30 feet RA = 25 feet

Source: CNVRPA staff work based on zoning regulations of each municipality,
April 1979.

4. Building Height Limitations

The maximum height of buildings is controlled by zoning ordinances in 12 municipalities, and by the Basic Building Code in the one municipality which has failed to adopt zoning. The maximum building height for residential structures in the Region varies from 30 feet in Thomaston and Wolcott, 35 feet for Beacon Falls, Middlebury, Oxford, Prospect, Waterbury, Watertown and Woodbury, to 40 feet in Cheshire, Naugatuck and Southbury (see Table 16).

The maximum building height for commercial buildings shows even greater variation. Beacon Falls and Wolcott limit commercial buildings to 30 feet, while at the other extreme, Naugatuck allows 60 foot buildings in the B-1 zone, Watertown allows 70 foot buildings in the BC zone, and Waterbury places no limit at all on commercial buildings in the Central Business District. A similar degree of variations is also found among the building height limitations established for industrial, office and multi-family uses of land. (See Table 17.)

Regulations governing the maximum height of buildings may very easily contribute to future solar shading problems due to the lack of control that zoning ordinances exercise over specific building heights. None of the zoning ordinances in the Region require uniform building heights, or mandate performance standards for light or solar access on each lot. Consequently, there is no guarantee that a homeowner will be protected from shading caused by a neighbor's building when the structure is within the height limitations of the zoning ordinance. As an example, a 15 foot single story dwelling on the periphery of the Central Business District (CBD) of Waterbury, would not be protected under zoning from a neighbor building a skyscraper in the CBD, since there is no height limitation for buildings in this zone of Waterbury.

Table 16: Maximum Height of Buildings and Maximum Height Exceptions for Structures in Residential Zones of the Central Naugatuck Valley Region

Municipality	Maximum Building Height (feet)	Allows for Exception to Height Limitations for Residential Structures *	Maximum Area of Building's Roof Subject to Exception	Maximum Height Limitation for Structures Subject to Exception (feet)
Beacon Falls	35	Yes	25%	N.S.
Bethlehem	*	-	-	-
Cheshire	40	Yes	N.S.	N.S.
Middlebury	35	Yes	25%	N.S.
Naugatuck	40	Yes	20%	N.S.
Oxford	35	Yes	N.S.	N.S.
Prospect	35	Not Clear	N.S.	N.S.
Southbury	40	Yes	N.S.	N.S.
Thomaston	30	Not Clear	N.S.	N.S.
Waterbury	35	Yes	10%	15
Watertown	35	Yes	25%	N.S.
Wolcott	30	Yes	N.S.	N.S.
Woodbury	35	Yes	N.S.	N.S.

*Building height is regulated by the Connecticut Basic Building Code.

N.S. = not specified

Source: CNVRPA staff work based on the zoning regulations of each municipality, April 1979.

Table 17: Maximum Height of Buildings in Commercial, Industrial, Multi-Family and Office Zones of the Central Naugatuck Valley Region

Municipality	Maximum Allowable Building Height by Zone			
	Commercial	Industrial	Multi-Family	Office
Beacon Falls	30	30	-	-
Bethlehem ¹	*	*	*	*
Cheshire	40	50	-	-
Middlebury	35	35	-	-
Naugatuck	40/60 ²	40/60 ³	40	40
Oxford	35	35	35	-
Prospect	35	35	-	-
Southbury	40/30 ⁴	40	40	-
Thomaston	40	50	30	-
Waterbury	30/50/60/ no limit ⁵	60/80 ⁶	150	no limit
Watertown	35/40/70 ⁷	60	35/70 ⁸	-
Wolcott	30	30	30	-
Woodbury ⁹	30/40 ¹⁰	30	35	-

¹Maximum height of buildings in Bethlehem is regulated by the Connecticut Basic Building Code.

²B2 = 40, B1 = 60 feet

³I2 = 40, I1 = 60 feet

⁴B1, B2, B3, BBA, B3B, B4 = 40 feet B2A, B2B, B2C, B2E, B3C = 30 feet

⁵CN = 30, CA = 50, CG = 60, CBD = no limit

⁶IP = 60 feet IG = 80 feet

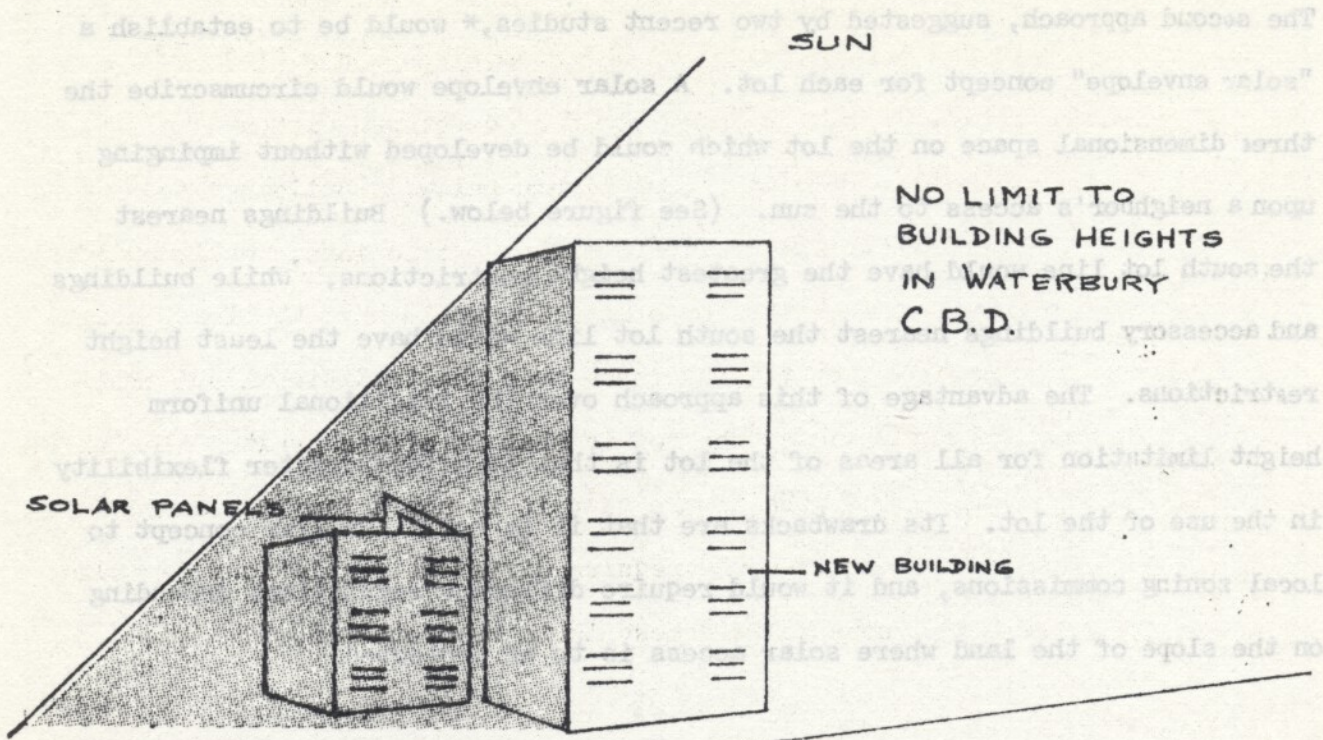
⁷BC = 70, BL = 35, BSC = 40, BG = 40

⁸Height varies by zone, GB = 70 feet, RA = 35 feet

⁹Maximum height can be increased to 50 feet in MQA, MQC and MQE district of Woodbury with additional setbacks.

¹⁰GB = 40 feet PB = 30 feet

Source: CNVRPA staff work based on the zoning regulations of each municipality, April 1979.

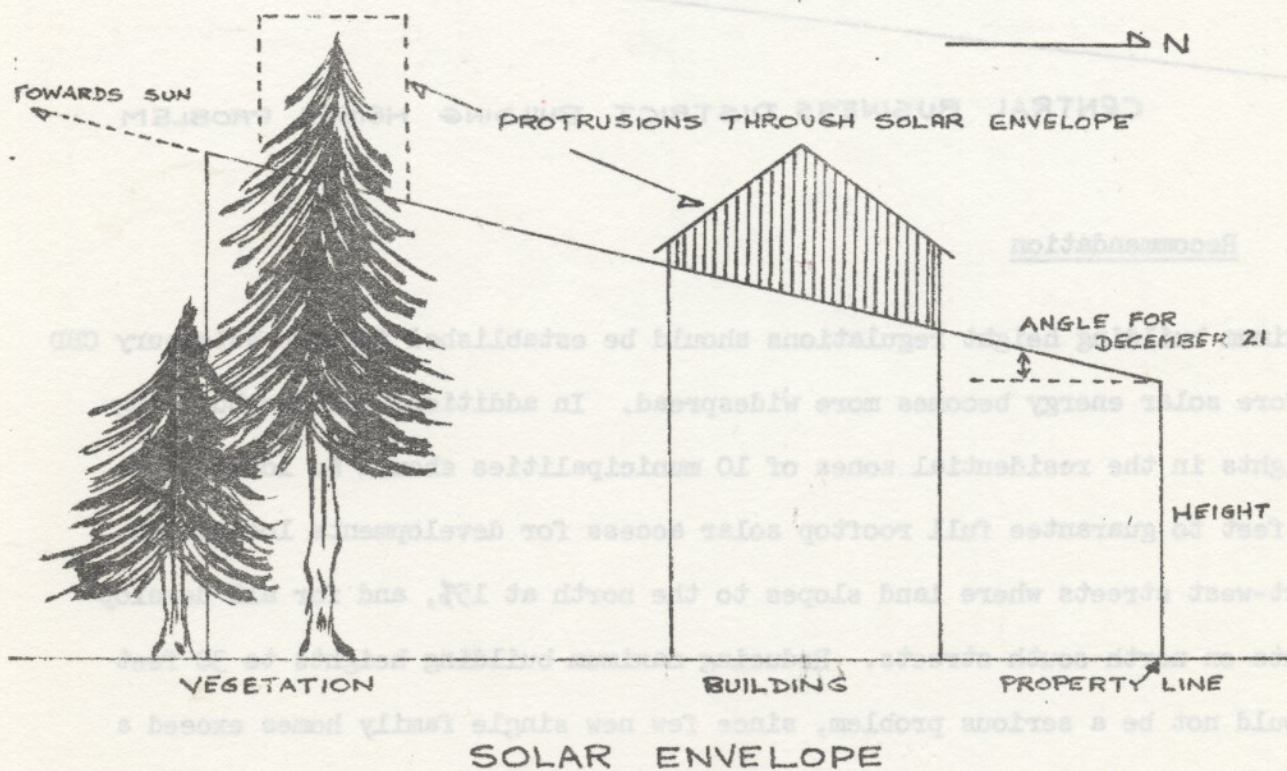


CENTRAL BUSINESS DISTRICT BUILDING HEIGHT PROBLEM

4.1 Recommendation

Maximum building height regulations should be established for the Waterbury CBD before solar energy becomes more widespread. In addition, maximum building heights in the residential zones of 10 municipalities should be lowered to 30 feet to guarantee full rooftop solar access for developments located on east-west streets where land slopes to the north at 15%, and for all developments on north-south streets. Reducing maximum building heights to 30 feet should not be a serious problem, since few new single family homes exceed a height of 30 feet.

The second approach, suggested by two recent studies,* would be to establish a "solar envelope" concept for each lot. A solar envelope would circumscribe the three dimensional space on the lot which could be developed without impinging upon a neighbor's access to the sun. (See figure below.) Buildings nearest the south lot line would have the greatest height restrictions, while buildings and accessory buildings nearest the south lot line would have the least height restrictions. The advantage of this approach over the traditional uniform height limitation for all areas of the lot is that it offers greater flexibility in the use of the lot. Its drawbacks are that it is not a familiar concept to local zoning commissions, and it would require different regulations depending on the slope of the land where solar access is to be protected.



See Protecting Solar Access for Residential Developments: A Guidebook for Planning Officials, Martin Jaffe, American Planning Association, May 1979 and Solar Access Law: Protecting Access to Sunlight for Solar Energy Systems, Gail Boyer Hayes, Environmental Law Institute, May 1979.

5. Exceptions to maximum heights of structures

Another potential shading problem may be created by uses exempted from the limitations of building height. Each of the twelve municipalities with zoning regulations allow certain equipment and/or structures to exceed the maximum height limitations set for the district in which it is located. Typically, towers, belfries, cupolas, steeples, spires, chimneys and elevator bulkheads are allowed to exceed the maximum height regulations of the district. Significantly, 11 of the 12 municipalities have placed no maximum height limitations for those uses which are exempted from the height regulations.

Furthermore, seven municipalities have not limited the maximum area of the building's roof, which is subject to the height exceptions. Consequently, a homeowner cannot fully rely on maximum building heights as a guide for determining the maximum possible shadow lengths sanctioned by zoning regulations. Large towers or belfries could threaten a neighbor's solar access in those instances where no limitation is placed upon their height or area.

5.1 Recommendation

Although towers, belfries, cupolas and steeples, etc. are unlikely to cause shading problems for solar collectors, these objects should still be subject to a maximum area and height limitation, and have a minimum setback from the property line, to avoid casting shadows onto a neighbor's property.

6. Projections into required yard areas

Architectural projections could also cause the shading of solar energy systems. In those instances where architectural features such as cornices, eaves, canopies, marquees, pilasters and similar features are allowed to project into the area required for setbacks from a street, side or rear property line, solar energy

systems could be subject to some minimal level of shading. Significantly, six municipalities in the Region have not specified the maximum allowable projection of architectural features into the required setback area.

This could be a serious issue if zoning commissions were to interpret their regulations' lack of specificity as a sanction for extremely long roof overhangs into required yard areas. Architectural projections do not appear to be a serious barrier to solar access in the other six municipalities of the Region, since architectural projections are limited to extensions of 1 foot (Wolcott), 2 feet (Naugatuck and Waterbury), or 3 feet (Cheshire and Southbury). Moreover, since the typical residential building has a pitched roof, the top of the building would loom as a larger barrier to sunlight in all municipalities than the architectural projections at the roof's eave. The only exception would be flat roofed homes utilizing excessively large architectural projections, and even in this case it would only be under certain rare circumstances that architectural projections would have an impact upon a neighbor's access to the sun.

6.1 Recommendation

All zoning regulations should specify the maximum allowable projection into required yard areas.

7. Maximum height of fences and other similar structures

One of the fears of some solar collector owners is that a neighbor could build a "spite fence," and thus cut off his/her access to the sun. This appears to be a possible, but unlikely, problem in 5 municipalities in the Region which have set either no maximum height limitations for fences, terraces or similar structures, or have not specified how these structures are to be regulated. One could imagine that if one's neighbor built a 40 foot fence along the property line, a solar shading problem could be created.

In Woodbury, the Town Planner indicated the Commission exercises no control over the maximum height of a fence. Consequently, a neighbor who, for reasons best known to him/herself, chooses to build a 40 foot fence, using telephone poles for stakes, would not be violating Woodbury's zoning regulations!

For the seven municipalities which have regulated the height of fences, it appears unlikely that a neighbor's fence could pose a shading problem. The maximum allowable height of fences ranges from 4 feet in Wolcott, to 8 feet in Cheshire. The only way that a fence of 8 feet could become a problem would be if solar collectors were installed on the ground as close as possible to the fence, as allowed by minimum setback requirements for accessory buildings and structures.

7.1 Recommendation

All municipalities should establish reasonable fence height standards, and specify the degree to which the zoning board of appeals may vary these standards (if at all). This approach should provide greater security for owners of ground-mounted solar collector panels, since a neighbor then will not be at perfect liberty to build a spite fence, or an aesthetic barrier which could shade the solar collectors.

8. Accessory building regulations

Accessory buildings on adjoining lots may limit solar access for solar energy systems located on the ground, and passive solar designs integrated into the wall of the building. The problem appears to be greatest in the two municipalities which allow for less restrictive side and rear setbacks for accessory buildings, but which have not established more restrictive height standards for these structures (Watertown and Woodbury). Under these circumstances, an accessory building could presumably be built to the same height limitations as the principal building (35 feet in the case of Waterbury and Woodbury).

Five municipalities have restricted the maximum height of accessory buildings to 12 feet (Cheshire, Middlebury and Wolcott), or 15 feet (Naugatuck and Waterbury). Nevertheless, even these height restrictions on a neighbor's garage or shed are insufficient to guarantee solar access for the rear or side yards, or the south wall of dwellings built on flatland. As an example, on December 21st, a 15 foot accessory building located on a flat piece of land in the R8 zone of Naugatuck, and 5 feet from the side property line, would cast a 45 foot shadow over the neighbor's property. This shadow length far exceeds the minimum rear and side yard setbacks allowed in the R-8 zone (see Tables 14 and 15).

As can be seen in Table 3, in addition to Naugatuck, three other municipalities (Cheshire, Watertown and Woodbury) allow accessory buildings as near as 5 feet from the property line. Middlebury allows accessory uses within 15 feet of a rear or side lot line, and Wolcott allows property owners, by mutual agreement, to build accessory buildings on the property line.

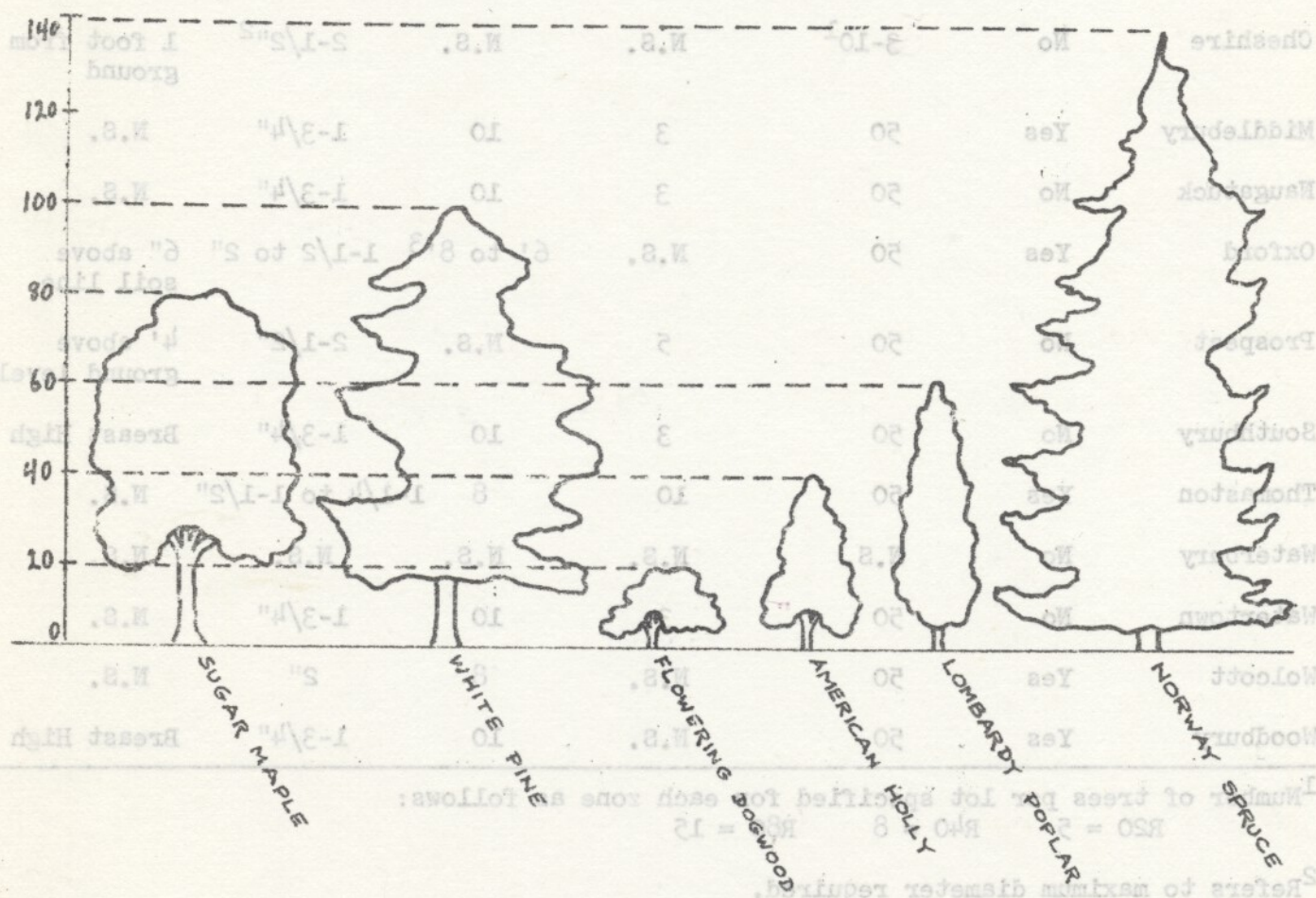
The fact that about 87% of all roofs of buildings in Waterbury, and 89% of all roofs of buildings in Southbury, were improperly oriented to accommodate rooftop solar energy systems in 1970, clearly points to the importance of protecting side and rear yard solar access for those wishing to install ground-mounted solar collector panels.

8.1 Recommendation

Accessory building heights can be controlled either by establishing height limitations for these structures which are consistent with solar access or by adopting solar envelope regulations as recommended earlier under the discussion of building height limitations.

9. Street Tree Requirements

The most serious and widespread shading problems are caused by trees, because they may be planted on or near property lines, and reach heights far in excess of maximum allowable building heights. Mature deciduous trees, such as maples and oaks, can reach heights at maturity anywhere from 65 to 120 feet.



Street trees planted within the street right-of-way are clearly regulated by planning commissions in the Central Naugatuck Valley Region. Four municipalities (Middlebury, Oxford, Thomaston, and Wolcott) specify that street trees shall be planted in all subdivisions. The remaining nine municipalities have adopted street tree standards, but have left the final decision on the need for street trees to the discretion of the planning commission. As can be seen in Table 18, almost all of the subdivision regulations specify the spacing of street trees, and the initial size of the saplings to be planted along the public way.

Table 18: Regulations Governing the Planting of Street Trees
in Residential Subdivisions in the Central Naugatuck
Valley Region

Municipality	Required Planting of Street Trees	Minimum Spacing of Trees Along Street	Minimum Distance from Edge of Pavement (feet)	Minimum Height of New Tree	Minimum Caliper of New Tree Trunk	Place of Measurement of Tree Caliper
Beacon Falls	No	N.S.	N.S.	N.S.	N.S.	N.S.
Bethlehem	No	50	3	10	2"	Breast High
Cheshire	No	3-10 ¹	N.S.	N.S.	2-1/2" ²	1 foot from ground
Middlebury	Yes	50	3	10	1-3/4"	N.S.
Naugatuck	No	50	3	10	1-3/4"	N.S.
Oxford	Yes	50	N.S.	6' to 8' ³	1-1/2 to 2"	6" above soil line
Prospect	No	50	5	N.S.	2-1/2"	4' above ground level
Southbury	No	50	3	10	1-3/4"	Breast High
Thomaston	Yes	50	10	8	1-1/4 to 1-1/2"	N.S.
Waterbury	No	N.S.	N.S.	N.S.	N.S.	N.S.
Watertown	No	50	3	10	1-3/4"	N.S.
Wolcott	Yes	50	N.S.	8	2"	N.S.
Woodbury	Yes	50	N.S.	10	1-3/4"	Breast High

¹Number of trees per lot specified for each zone as follows:
R20 = 5 R40 = 8 R80 = 15

²Refers to maximum diameter required.

³Refers to Type II trees only. Type II trees are to be planted beneath utility lines, since they only reach heights of 15 to 40 feet at maturity. Trees included in the Type II category are Pauls Scarlet Hawthorn, Washington Hawthorn, Siberian Crab, Hopa Crab, Schneidecker Crab, and Eastern Hop Horn.

Source: CNVRPA staff work based on the subdivision regulations of each municipality, April 1979.

The principal problem posed by street tree regulations is that there is little or no consideration for the (1) type of trees, (2) their ultimate size, or (3) their shading characteristics. At their discretion, a planning commission could decide to require evergreen rather than deciduous trees; it could require the planting of trees which reach exceptionally tall heights at maturity; it could require trees which are generally quite brittle, posing a danger to solar collectors located on rooftops or in yard areas; and it could require trees which allow for minimal penetration of sunlight through the bare branches in the winter.

In those nine municipalities where tree planting regulations are limited to specifying discretionary standards, town planners have indicated that their commissions have not exercised these powers, largely because most subdivisions in these municipalities occur in relatively wooded areas and do not require any extra plantings. The only developments which may require trees are the potentially more annoying commercial and industrial developments. In these cases, tree planting is usually encouraged in the preliminary stages of the subdivision or site plan so that the development conveys an aesthetic appearance.

10. Nonconforming Use Regulations

According to the Town Planners in Cheshire, Southbury and Woodbury, the planning commissions in these municipalities have not yet considered the use of trees and other forms of shrubbery as a means of promoting energy-efficient landscaping, or as a means of improving the micro climate of a neighborhood. In those instances, where street trees are required, it is generally for aesthetic reasons and with little or no consideration for the shading effects on yards or houses.

While the zoning regulations of the remaining nine municipalities do not indicate whether the zoning board of appeals can vary setback requirements, it probably is safe to say that variances can be granted in these towns as well. One clear problem for those concerned with permanent solar access is that zoning boards of appeal in the Region are essentially free to modify any zoning regulations.

9.1 Recommendation

Subdivision regulations should be revised to establish standards for the type of trees suitable for public streets. Tree species chosen should allow for maximum penetration of sunlight through the bare branches in the fall and winter. Furthermore, trees which drop their leaves earliest in the fall may be desirable since solar access may be affected as much by late leaf drop as by minimal light penetration of bare branches in the dead of winter. It does not appear advisable to set maximum tree height standards since street trees, when sited properly, can provide needed shade in the summer without seriously interfering with light penetration through bare branches in the winter. Of course, by not controlling tree height, more emphasis must be placed on the siting of street trees and the selection of trees which are consistent with year round solar access. The Oxford subdivision regulations already provide a list of tree species suitable for planting under utility lines. Since this list identifies trees having a maximum height at maturity of 40 feet or less, it could be used with some modification to protect solar access for homes along public streets.

10. Nonconforming Use Regulations

Solar access may also be subject to the desires of the local zoning boards of appeal. An owner of a solar collector could face the possibility that an adjoining property owner would shade his/her collector by asking the zoning board of appeals to vary the minimum setback, or maximum height requirements, for his/her property. Three municipalities specifically indicate that minimum setback requirements can be varied by the approval of the zoning board of appeals. While the zoning regulations of the remaining nine municipalities do not indicate whether the zoning board of appeals can vary setback requirements, it probably is safe to say that variances can be granted in these towns as well. One clear problem for those concerned with permanent solar access is that zoning boards of appeal in the Region are essentially free to broadly vary zoning regulations.

In 1977, the state legislature passed Public Act 77-509, which allows the zoning commission to limit the variance powers of the zoning board of appeals. So far, only one of the Region's zoning commissions has established any limitations on the activities of the zoning board of appeals regarding nonconforming buildings and lots.

Moreover, none of the zoning commissions has yet limited the degree to which the zoning board of appeals may vary the three critical standards affecting solar access; height, setback and area requirements. The lack of control over the activities of the zoning board of appeals clearly underscores the limitations of zoning as a perfect method of protecting solar access.

10.1 Recommendation

Perhaps the best means of preserving permanent solar access, and fortifying the integrity of zoning regulations, would be for each zoning commission to limit the variance powers of the local zoning board of appeals. As an example, zoning commissions could specify that minimum setback, frontage and lot size, and maximum building height could only be varied up to 10% over the standards in the local zoning regulations.

11. Regulations to control trees on private property

To a lesser degree, it is also possible for a planning commission to regulate the height of vegetation on private property. In most cases, planning commissions in the Region already specify that in new subdivisions, developers should make the best use of the natural terrain to preserve substantial trees, woods and water resources. While this provides the commission with some control over trees, the current wording of subdivision regulations tends to create a conflict between the preservation of solar access and the preservation of substantial trees.

However, if a planning commission should decide to utilize its land use controls in the interest of providing solar access, it could encourage the removal of small stands of trees near the location of the south wall of the house. This approach, of course, does not prevent a homeowner from planting trees after the development is completed. At that point, subdivision regulations no longer exercise any influence on vegetation planted on private property. However, zoning regulations may have some degree of control over vegetation if the location, height, or type of trees has an impact upon the public health and safety. As an example, five of the Region's zoning regulations (Cheshire, Middlebury, Waterbury, Wolcott, and Woodbury) require visibility at corner intersections in the interest of highway public safety. In this case, vegetation on private property is an issue affecting the public, since automobile accidents may be caused by the lack of visibility at a corner intersection.

Similarly, Connecticut state enabling legislation allows utility companies (telephone, telegraph and electricity) to cut trees on private property, without the consent of the property owner, if the state finds that removal of the trees is necessary for the public convenience (see Section 16-234 of the General Statutes of Connecticut). A third precedent for the public regulation of trees on private property can be found under the state enabling legislation for public shade trees. Under Section 23-60 of the General Statutes of Connecticut, tree wardens may plant, trim, spray or care for trees on private property (with the written consent of the owner) up to a distance of 10 feet away from a public highway. Under these guidelines, the tree warden is essentially limited to caring for and pruning trees in order to provide shade for public highways, and to maintain ornamental vegetation along the public way. However, if solar access should become a matter of public concern, then a tree warden could be authorized to trim public shade trees and trees on private property which are shading solar collector panels. A number of model ordinances developed for counties and municipalities in California have already assigned tree wardens the responsibility of trimming trees when they violate solar access standards.

11.1 Recommendation

It is possible that zoning regulations could be used to guarantee solar access by

(1) limiting the height of trees, (2) applying performance standards to the height of vegetation, or (3) by using the zoning envelope or solar envelope concept to regulate vegetation. None of these approaches has actually been tested in Connecticut, so it is uncertain that zoning could be extended into this sensitive area of private property rights. Undoubtedly, this approach to tree regulation could run into serious opposition, since a person's right to plant vegetation on his/her property has been a long assumed right of property ownership. This does not mean that zoning could not play a role; it merely indicates that zoning provisions limiting tree height on private property should proceed cautiously, since they are not likely to be accepted easily.

Perhaps the most manageable short term solution to tree shading would be to require solar skyspace easements for lots in all new subdivisions. The State of California Solar Rights Act, passed in 1978, provides for this type of approach. It states "the legislative body of a city or county may by ordinance require, as a condition of the approval of a tentative map, the dedication of easements for the purpose of assuring that each parcel or unit in the subdivision for which the approval is sought shall have the right to receive sunlight across adjacent parcels or units in the subdivision for which approval is sought for any solar energy system provided that such ordinance contains all of the following." The Solar Rights Act goes on to state that the necessary items that must be contained in a valid local ordinance include, (1) specification of standards for determining exact dimensions of easements, (2) specifications on the restrictions placed on vegetation, buildings and other objects, (3) specifications for the terms, if any, under which an easement may be revised or terminated, (4) specifications that easement will not affect densities or lot coverage standards currently in effect, and (5) specifications that the ordinance does not apply to condominiums in an existing building where no new structures are added, but where internal airspace is divided.

The advantage of establishing solar skyspace easements is that the planning and

zoning commission need not directly become involved in the administration and enforcement of solar access standards. Rather, the planning and zoning commission need only require the development of private solar skyspace easements as a pre-requirement to subdivision map approval. In Connecticut, this process will probably require new enabling legislation that allows planning and zoning commissions to stipulate the inclusion of private solar easements on individual lots as a condition of subdivision map approval.

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to condominiums in an existing building where no new structures are added, but

D. Magnitude of the Tree Shading Problem

One installer indicated that a solar domestic hot water system in Waterbury was shaded by a tree that was supposed to have been removed by the landlord at the time of installation. However, the landlord stalled, since he apparently did not want to cut the tree for his tenants. Consequently, for the first eight months after the installation, the domestic hot water system was essentially turned off until the landlord agreed to remove the tree. (See picture on page 105.)

In June 1979, interviews were held with 15 of the 16 known installers of solar energy systems in the Region to determine (1) the extent to which existing solar domestic hot water installations in the Region have required the removal of trees to enhance solar access, and (2) the extent to which future tree growth on the property, on a neighbor's property, or on a street right-of-way may affect solar access. It was our assumption that tree shading of roofs on existing houses would pose little or no barriers to the widespread use of solar energy, if existing

owners of solar energy systems were commonly removing trees in order to install their systems. Significantly, as a group, installers stated that trees had to be removed (or should have been removed) prior to the installation of almost 40% of the 21 solar domestic hot water systems in operation in the Region. This clearly indicates that solar energy is not merely appealing to those homeowners who actually have adequate solar access - although adequate solar access is certainly a critical factor.

While existing shading problems have not been a bar to the installation of solar energy systems, they have restricted the solar retrofit option in numerous cases.

Several installers confirmed that they had turned down jobs, or advised clients not to install solar systems, either because of (1) improperly oriented roofs, or (2) because shading from trees essentially eliminated the viability of the solar energy option. This limited survey of installers, of course, does not even count all those sensible people who arrived at the decision to forego solar after making their own assessment of their tree shade problems, and the improper orientation of their roofs. Nonetheless, despite the potential problems of shading, it is clear that some consumers are not seriously considering the potential maladies that emerge from tree shading in their decision to install solar. Interviews with several of the solar energy installers in the Region revealed that in certain instances, tree cutting can become an emotional issue which could discourage the

use of solar energy, or lead to the discontinued use of shaded solar collector

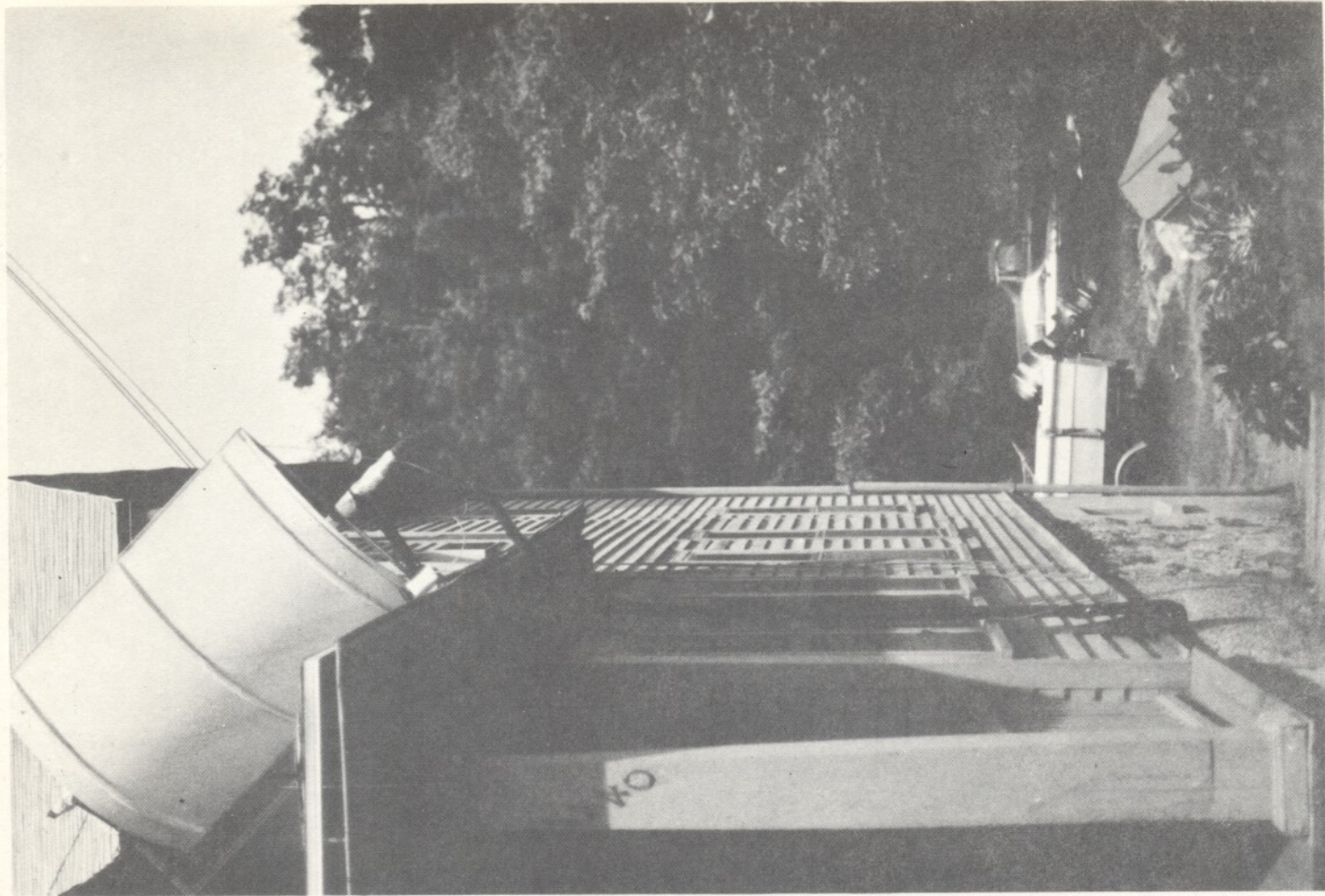
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Our second assumption was that tree shading of roofs could pose significant barriers to the efficiency of solar energy systems in the future if there were any threat of shading from trees on neighbor's property within the next 10 years. Significantly, three of the 15 installers stated that shading from a neighbor's tree was a distinct possibility for 4 of the 21 solar domestic hot water systems located in the Region. Not surprisingly, 3 of the 4 installations that face serious shading problems in the future are located in the high density residential

neighborhoods of Waterbury where small lot sizes, minimal setback requirements and steep north facing slopes facilitate the development of tree shading problems.

In order to evaluate the installers perceptions of future tree shading, each of the solar installations was inspected by the CNVRPA staff. A visual inspection led to the conclusion that solar shading from neighbor's trees may be quite likely for an additional 3 solar domestic hot water installations in the Region. In effect, this means that 7 of the 21 solar domestic hot water installations in the Region will soon face the spectre of tree shadows which are immune to the homeowners pruning shears, and which will continue growing in length to ultimately darken the surface of the solar collector panels.



Evergreen tree blocking the solar access for a solar concentrator with tracking device.

After, July 1979

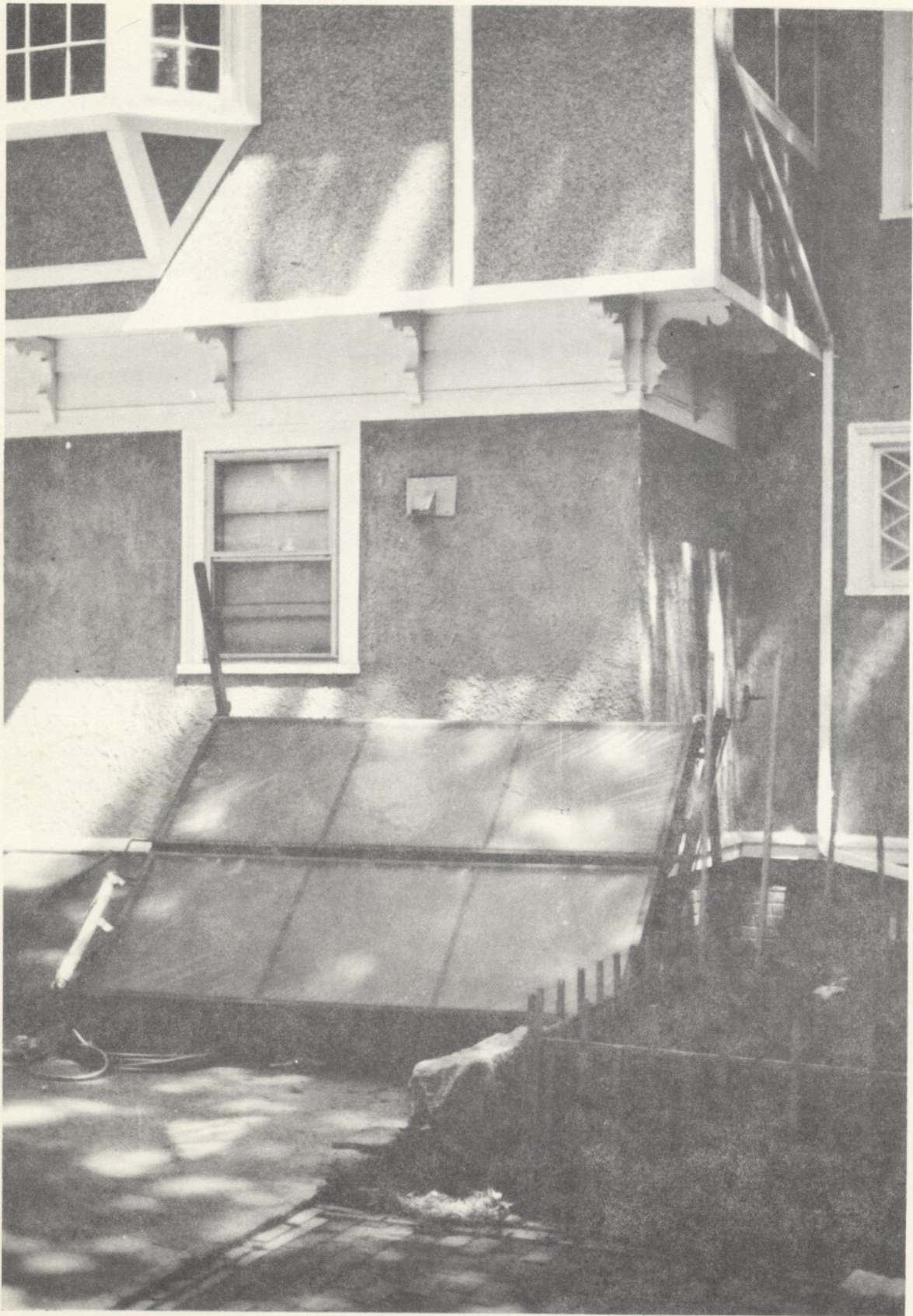


Before, June 1979

This situation indicates that some installers and homeowners appear to be deficient in their understanding of sun angles and tree growth characteristics when making assessments of solar access.

Installers were also asked what the owner's reactions were to the possibility of future shade problems created by neighbor's trees. According to the three installers (whose views, of course, must be taken with some appreciation of their own self-interests), owners were either not concerned with shading problems, or felt that the laws would change in the future so as to establish sunrights for their installations. Clearly, the fact that homeowners are willing to make investments in solar equipment on the expectation that legislation will eventually be enacted to protect their sunrights, indicates that solar litigation, rather than legislation, will not be far away.

Furthermore, shading from trees on the owner's property may also be a serious issue, especially since many people may be emotionally attached to their trees and may be quite opposed to cutting or pruning when this would seriously affect the appearance of their house or lawn. In addition to the seven homes that will be affected by shade from trees on neighboring property, six other installations will be faced with potential shading problems within the next 10 years from trees on the same lot as the collector panels. (See picture on page 107.) In effect, 13 of the 21 solar domestic hot water systems installed by contractors in the Region will be subject to some level of shading before 1989.



Solar collector panels shaded by trees on June 24, 1979.

E. SUMMARY

As solar energy systems become more widely accepted, Connecticut planning and zoning commissions will undoubtedly be faced with the task of evaluating the impact of current land use policies and regulations on solar access and the installation of solar energy systems. Although no municipality in the Central Naugatuck Valley Region has specifically prohibited the installation or use of solar energy systems, these systems may inadvertently be prohibited by specific requirements found in most local zoning regulations. In particular, the most likely barriers to be encountered by a person wishing to install a solar energy system are setback requirements, accessory use regulations, maximum ground coverage regulations, building height regulations, and building height exception regulations.

These potential barriers generally apply to those cases where solar energy systems are added to an existing structure not originally designed for the use of solar energy. In contrast, most if not all of the legal barriers to the installation of solar energy systems can be eliminated by properly designing a subdivision and each individual lot, and dwelling to be properly oriented to accommodate solar energy systems.

As a result of the mandate of Public Act 78-314, energy has become a valid component of local land use planning policies and regulations. Consequently, there should no longer be any doubt that planning and zoning commissions are authorized to encourage the use of solar energy and other renewable energy resources. The first task that lies before us is to eliminate or revise existing land use policies or regulations which may inadvertently bar the use of solar energy systems. This is a task which should be accomplished by all Connecticut planning and zoning commissions.

The second task will be to develop incentive regulations which encourage the use of solar energy under appropriate conditions in future residential development. The extent to which planning and zoning commissions wish to encourage solar energy will vary from town to town depending upon the opportunities and constraints of local geography, local land use and energy policies and local climate. At one extreme we have found that a number of municipalities in the western part of the United States have already adopted regulations requiring the mandatory installation of solar energy systems. This approach appears to be somewhat premature in Connecticut largely because the enabling legislation created through Public Act 78-314 only indicates that the use of solar energy is to be encouraged and not required. Consequently, the preferred regulatory approach in Connecticut, at this point in time, is to provide for solar energy through such mechanisms as planned solar residential development regulations, solar access overlay zones or cluster regulations. As a first step in this direction the Central Naugatuck Valley Regional Planning Agency (CNVRPA) has developed model regulations including zoning definitions, zoning amendments and a planned solar residential development regulation for the Town of Cheshire which incorporates the recommendations made in this study. These regulations are presented in Appendix 3. While these model regulations are expected to be consistent with the land use policies of the municipality of Cheshire they may or may not be an appropriate approach for other municipalities in Connecticut.

The potential legal barriers to solar energy systems identified in this study should provide a comprehensive check list of possible regulatory reforms to be made by Connecticut planning and zoning commissions. However, the extent to which planning and zoning commissions provide incentives for the future use of solar energy will necessarily depend upon the energy and land use policies of each municipality and the vision each has of the world ahead.

***** Article MCA-14

SOLAR SPACE HEATING, SPACE COOLING, AND DOMESTIC HOT WATER EQUIPMENT

MCA-1400.0 Definitions

Active solar space heating system: A solar heat collector is added to a building and some positive means such as a motor driven fan or pump is provided to move the energy from the collector to the place where it is to be stored or used. A positive means is also employed to remove the heat from storage and distribute the heat as needed. The collector can be an integral part of the structure or it can be a separate entity either attached to or separate from the structure.

Active solar space cooling system: A solar heat collector is added to a building and some positive means such as a motor driven fan or pump is provided to move the energy from the collector to the place where it is to be stored or used. In either case a positive means is also generally employed to remove the heat (or cold) from storage and to distribute the cooling effect produced by using that heat as needed. The collector can be an integral part of the structure or it can be a separate entity either attached or entirely separate from the structure.

Passive solar space heating system: The building itself is designed as a solar heat collector and no conventional energy (such as oil, gas or electricity) is utilized to aid the collection or to distribute the heat that is collected. Instead the building is heated by direct solar radiation entering the windows and by re-radiation from building surfaces to the occupants. In general such buildings have a substantial amount of glass facing south. The glass is generally set in the building so as to maximize the solar heat gain to the inside of the building in the wintertime and minimize solar gain during the summertime.

Passive solar space cooling systems: The building is designed to aid the loss of heat from the inside of the building to the outside without the use of conventional energy sources. Heat loss from the interior is generally achieved by natural ventilation, evaporative cooling and radiation loss.

Hybrid system: The building contains a combination of both passive and active solar systems.

Solar domestic hot water system: An active or passive solar energy system is employed to heat water to be used for domestic purposes. An active system includes such elements as a solar energy

*****As Amended January 1, 1979

collector and some positive means such as a motor driven fan or pump employed to move the energy from the collector to the place where it will be stored and/or utilized. A passive system includes such elements as a solar energy collector or other collection mechanism and a method of moving the energy from the collector to the place where it will be stored and/or utilized, without the use of conventional energy sources. A solar domestic hot water system may have elements, such as solar energy collectors, pipes or ducts, pumps, and heat storage facilities, in common with solar space heating and/or space cooling systems in which case requirements applicable to each category of system involved must be met.

MCA-1401.0 Requirements applicable to active solar energy systems.

MCA-1401.1 Solar energy gathering devices (solar collectors) shall be provided with a name plate identifying the manufacturer's name and address and the model and serial number. Manufacturers of the solar energy gathering devices shall have each model tested by an independent accredited testing laboratory. The laboratory shall meet the standards of ASTM, ANSI, and ASHRAE. The test results shall be published as part of the manufacturer's literature. Solar energy gathering devices shall be tested in accordance with the ASHRAE 93-77 and NBSIR 77-1226. The requirements in this subsection shall not apply to solar energy gathering devices constructed by an individual for installation on a single family residential dwelling which is or will be occupied by the individual.

MCA-1401.2 All solar energy gathering devices (solar collectors), accessories and controls, shall be installed in accordance with manufacturer's instructions. All components of active solar energy systems shall be securely installed and shall be subject to all other applicable sections of the state building codes. Where applicable, work shall be performed by licensed mechanics, such as plumbers, steamfitters, electricians, or other persons licensed to perform the activities involved, except that individuals who own and occupy or will occupy, single family residential dwellings, including such dwellings under construction, may install solar energy gathering devices, accessories, controls and other components of active solar energy systems without regard to such licensing requirement, pursuant to this section and to section 20-340 of the General Statutes.

MCA-1401.3 All active solar energy systems shall be trimmed with automatic safety controls to prevent the equipment and systems from operating in an unsafe manner.

MCA-1401.4 The installation of all solar energy heating, cooling, or domestic hot water systems shall require a building permit prior to construction and a certificate of occupancy upon completion.

*****As Amended January 1, 1979

MCA-1402.0 Requirements applicable only to solar energy gathering devices (solar collectors) assembled on site.

MCA-1402.1 Solar energy gathering devices (solar collectors) which are assembled on site and constitute part of an active solar energy system shall require complete design documents including plans, specifications and a calculation of the estimated amount of energy to be provided by the solar collectors, all bearing the stamp of a licensed professional engineer registered in Connecticut and to be made available to the building official. The site assembled solar collector or an equivalent collector or mock-up shall be tested on site or be, or have been, tested in an independent accredited testing laboratory to verify the above calculation.

MCA-1402.2 Exemption to above requirements: The requirements in this section shall not apply to solar collectors assembled on site by an individual for installation on a single family residential dwelling which is or will be occupied by the individual.

MCA-1403.0 Requirements applicable to all solar space heating systems. All active, passive, and hybrid solar space heating systems shall require either: (1) A supplemental space heating system which in itself is capable of producing heat in sufficient quantity to supply the full load requirement of the system, exclusive of the availability of solar energy, or stored energy derived from solar energy, from the solar space heating system; or (2) Performance of the following calculations, to be certified by a licensed professional engineer registered in Connecticut and to be made available to the building official.

Building design heat loss and heat gain calculations, to be performed in accordance with the methodology set forth in the ASHRAE handbook of fundamentals; a month-by-month estimate of the heating requirement accomplished using the degree day method or other ASHRAE approved methodology; a month-by-month estimate of the energy to be contributed by the solar space heating system; a month-by-month estimate of the amount of auxiliary energy will be required to supplement the solar space heating system; and a supplemental space heating system shall be provided which a licensed professional engineer registered in Connecticut certifies as having sufficient capacity that the solar space heating system and supplemental system together will produce heat in sufficient quantity to supply the full load heating requirement of the system.

MCA-1403.1 Exemption to above requirements: The supplemental space heating system and the certified performance calculations required by this section shall not be required for any solar

*****As Amended January 1, 1979

space heating system constructed by an individual for installation on or in a single family residential dwelling which is or will be occupied by the individual.

MCA-1404.0 Requirements applicable to all solar domestic hot water heating systems.

All solar domestic hot water heating systems shall require either:

(1) A supplemental domestic hot water heating system which in itself is capable of meeting the entire hot water heating requirement of the system, calculated in accordance with an ASHRAE approved methodology, exclusive of the availability of solar energy, or stored energy derived from solar energy, from the solar domestic hot water heating system; or (2) Performance of the following calculation to be certified by a licensed professional engineer registered in Connecticut and to be made available to the building official.

A month-by-month estimate of the energy to be contributed by the solar domestic hot water heating system; a month-by-month estimate of the amount of auxiliary energy which will be required to supplement the solar domestic hot water heating system; and a supplemental domestic hot water heating system shall be provided which a licensed professional engineer registered in Connecticut certifies as having sufficient capacity that the solar domestic hot water heating system and supplemental system together will produce hot water in sufficient quantity to supply the entire domestic hot water requirement as calculated in accordance with an ASHRAE approved methodology.

MCA-1404.1 Exemption to above requirements: The requirements in this section shall not apply to any solar domestic hot water heating system constructed or installed by an individual on or in a single family residential dwelling which is or will be occupied by the individual.

*****As Amended January 1, 1979

Appendix 2A: Minimum Frontyard Setbacks required to Protect Ground, South Wall, and Full Rooftop Solar Access for Residential Buildings located on Flatland in the Central Naugatuck Valley Region

Municipality	Maximum Building Height ¹	Ratio of North Shadow Length to Height of House (Flatland) ²	Maximum Length of Shadow Cast by Maximum Allowable Building Height ³	Minimum Frontyard Setback for South Wall Solar Access ⁴	Minimum Frontyard Setback for Ground Solar Access ⁵	Minimum Frontyard Setback for Full Rooftop Solar Access Above 20 feet ⁶	Lot Size Categories Where Houses Across the Street could Shade South Wall ⁶	Lot Size Categories Where Houses Across the Street could Shade Full Rooftop ⁸
Beacon Falls	35	3.71	129.8	33.9	37.9	3	45,000	45,000 None
Bethlehem					No Zoning Regulations			
Cheshire	40	3.71	148.4	43.2	47.2	12	All	None
Middlebury	35	3.71	129.8	33.9	37.9	3	None	None
Naugatuck	40	3.71	148.4	43.2	47.2	12	All	None
Oxford	35	3.71	129.8	33.9	37.9	3	All	None
Prospect	35	3.71	129.8	33.9	37.9	3	None	None
Southbury	40	3.71	148.4	43.2	47.2	12	30,000	None
Thomaston	30	3.71	111.3	24.7	28.7	No roof shading at zero lot line	None	None
Waterbury	35	3.71	129.8	33.9	37.9	3	All	None
Watertown	35	3.71	129.8	33.9	37.9	3	7,500	None
Wolcott	30	3.71	111.3	24.7	28.7	No roof shading at zero lot line	None	None
Woodbury	35	3.71	129.8	33.9	37.9	3	None	None

Source: CHVRPA staff work based on the zoning regulations of each municipality and the North Shadow Projection Table (Figure 27) in Protecting Solar Access: A Guidebook for Planning Officials, May 1979.

Appendix 2B: Minimum Frontyard Setback Required to Protect Ground, South Wall and Full Rooftop Solar Access for Residential Buildings located on South Facing Slopes of 15 Percent in the Central Naugatuck Valley Region

Municipality	Maximum Building Height ¹	Ratio of North Projection of Shadow Length to Height of House (15% south Slope) ²	Maximum Length of Shadow Cast by Maximum Allowable Building Height ³	Minimum Frontyard Setback for South Wall Solar Access ⁴	Minimum Frontyard Setback for Ground Solar Access ⁵	Minimum Frontyard Setback for Full Rooftop Solar Access Above 20 feet ⁶	Lot Size Categories where Houses Across the Street could Shade Full Rooftop ⁹	Lot Size Categories where Houses Across the Street could Shade Ground ⁸	Lot Size Categories where Houses Across the Street could Shade Full Rooftop ⁹
Beacon Falls	35	2.39	83.7	10.9	14.9	*	None	None	None
Bethlehem									
Cheshire	40	2.39	95.6	16.8	20.8	*	None	None	None
Middlebury	35	2.39	83.7	10.9	14.9	*	None	None	None
Naugatuck	40	2.39	95.6	16.8	20.8	*	None	None	None
Oxford	35	2.39	83.7	10.9	14.9	*	None	None	None
Prospect	35	2.39	83.7	10.9	14.9	*	None	None	None
Southbury	40	2.39	95.6	16.8	20.8	*	None	None	None
Thomaston	30	2.39	71.7	4.9	9.9	*	None	None	None
Waterbury	35	2.39	83.7	10.9	14.9	*	None	RM Maybe	None
Watertown	35	2.39	83.7	10.9	14.9	*	None	None	None
Wolcott	30	2.39	71.7	4.9	9.9	*	None	None	None
Woodbury	35	2.39	83.7	10.9	14.9	*	None	None	None

*No roof shadow at zero lot line setback.

Source: CNVTPA staff work based on the zoning regulations of each municipality and the North Shadow Projection Table (Figure 27) in Protecting Solar Access: A Guidebook for Planning Officials, May 1979.

Appendix 2C: Minimum Frontyard Setbacks Required to Protect Ground, South Wall and Full Rooftop Solar Access for Residential Buildings located on North Facing Slopes of 15 Percent in the Central Naugatuck Valley Region

Municipality	Maximum Building Height ¹	Ratio of North Shadow Length to Height of House (.5% north slope) ²	Maximum Length of Shadow Cast by Maximum Allowable Building Height ³	Minimum Frontyard Setback for South Wall Solar Access ⁴	Minimum Frontyard Setback for Ground Solar Access ⁵	Minimum Frontyard Setback for Full Rooftop Solar Access on 28 Ft House ⁶	Lot Size Categories where Houses Across the Street could Shade South Wall ⁷	Lot Size Categories where Houses Across the Street could Shade Full Rooftop ⁸	Lot Size Categories where Houses Across the Street could Shade Full Rooftop ⁹
Deacon Falls	35	8.51	297.9	118.0	122.0	35	All	All	45,000
Bethlehem					No Zoning Regulations				
Cheshire	40	8.51	340.4	139.2	143.2	55	All	All	All
Middlebury	35	8.51	297.9	118.0	122.0	35	All	All	None
Naugatuck	40	8.51	340.4	139.2	143.2	55	All	All	All
Oxford	35	8.51	297.9	118.0	122.0	35	All	All	All
Prospect	35	8.51	297.9	118.0	122.0	35	All	All	None
Southbury	40	8.51	340.4	139.2	143.2	55	All	All	All
Thomaston	30	8.51	255.3	96.7	100.7	10	All	All	None
Waterbury	35	8.51	297.9	118.0	122.0	35	All	All	All
Watertown	35	8.51	297.9	118.0	122.0	35	All	All	7,500
Wolcott	30	8.51	255.3	96.7	100.7	10	All	All	None
Woodbury	35	8.51	297.9	118.0	122.0	35	All	All	None

Source: CHVRPA staff work based on the zoning regulations of each municipality and the North Shadow Projection Table (figure 27) in Protecting Solar Access: A Guidebook for Planning Officials, May 1979.

1. Maximum building height is based on the zoning regulations of each municipality, July 1979.
2. The ratio of north projection of shadow length to the height of the house is derived from the study Protecting Solar Access for Residential Development: A Guidebook for Planning Officials. See page 34, figure 27, North Shadows Projection Table. The north shadow projection distance is a valuable tool for determining minimum setbacks for lots on east-west streets.
3. The maximum length of the shadow cast by the maximum allowable building height assumes a pitched roof building with dimensions of 24 feet by 50 feet. The shadow length is the product of multiplying the building height times the shadow length ratio.
4. The minimum front yard setback is derived by subtracting the 50 foot street right-of-way and one half the width of the 24 foot building from the maximum length of the shadow. This number represents the combined length of the front yard on both sides of the street and is divided by two to arrive at the minimum front yard setback needed for south wall solar access. As an example, when a 129.8 foot shadow is cast over 50 feet of street right-of-way and 12 feet of roof, 67.8 feet is left for the front yards of houses on both sides of an east-west street. Consequently, each front yard must have at least 33.9 feet to protect south wall solar access.
5. The minimum front yard setback for ground solar access assumes that solar collector panels will be located in front of the house but extend no further than 4 feet from the building's wall. This arrangement dictates that, at the very least, the building be setback 4 feet further than minimum front yard setback requirements to ensure that the collector panels do not violate front yard setback regulations. This arrangement, of course, is only feasible where accessory uses are allowed in the frontyard.
6. The minimum front yard necessary for full rooftop solar access assumes a building height of 28 feet with a 20 foot height to the eave of the roof.
7. The residential zones where shading could be an issue for south wall passive solar design concepts have been identified by an examination of minimum front yard setback requirements presented in Table 13 of this report.
8. Shading of solar collectors in the front yard assumes the panels are within 4 feet of the house wall. Three municipalities do not allow accessory uses in the front yard (Watertown, Waterbury and Woodbury). This precludes solar collector panels from a front yard location. In addition, topographic conditions, aesthetic factors or tree shading may very well spell the need for greater front yard setbacks to allow for flexibility in the siting of ground mounted solar collector panels.
9. Rooftop solar access emerges as a problem on north slopes of 15 percent in those municipalities with allowable building heights of 40 feet and in those municipalities where minimum front yard setback requirements are less than 35 feet.

Appendix 3: Proposed Planned Solar Residential
Development Ordinance

PREAMBLE

The residents of _____ face the uncertainty of conventional energy source supplies and the certainty of rapid cost increases for conventional energy sources due to the growing scarcity of conventional energy resources. The Connecticut State Legislature has encouraged the use of solar energy resources, energy efficient patterns of development and energy conservation practices in land use development in an effort to decrease our reliance on imported fossil based fuels. Furthermore, the Central Naugatuck Valley Regional Planning Agency has determined that solar water heating systems and passive solar design concepts for space heating are technically mature and are ready for commercial applications. The CNVRPA has found that properly installed solar domestic hot water systems are more cost effective than electric and fuel oil fired hot water systems based on a life cycle cost analysis of each. Under the local climatic conditions found in _____ currently available solar energy systems should be able to provide from 60 to 80 percent of the water heating requirements for a typical single family residence and passive solar design concepts should be able to provide up to 50 percent of the space heating requirements of the same structure.

Intent

Planned Solar Residential Development. It is the purpose of this section to provide standards and procedures for the design and development of planned residential developments which utilize solar energy to meet a significant fraction of the space heating and domestic hot water heating needs of dwelling units contained therein.

1. Qualifying Standards. No tract of land shall be considered for a planned solar residential development unless it meets the following minimum qualifying standards.
 - 1.1 The tract shall consist of a single lot or a number of contiguous lots under one ownership or control having a total area of not less than 10 acres.
 - 1.2 The tract shall be served by public water and public sanitary sewers.
 - 1.3 The tract shall have at least 75 percent of its land surface with slope orientations which are (1) between 90 degrees east of true south and 90 degrees west of true south, and/or (2) predominately flat (slopes of less than 5 percent oriented in any direction).
 - 1.4 The tract shall have frontage onto a major state highway and other roads that the planning and zoning commission may approve.
2. Procedures. All planned solar residential developments shall be considered special permits subject to its requirements and procedures in addition to those specified herein. Prior to the application for a special permit, a preliminary plan of development of the entire tract shall be submitted to the planning and zoning commission. The purpose of the preliminary plan shall be to indicate the general intent, arrangement and orientation of the proposed uses, the type

of solar energy systems to be installed, the proposed orientation and design of streets and lots, the proposed density, and the relationship of densities to slopes and solar access. The Commission shall approve, approve with modification or disapprove the preliminary plan within 65 days from the submission thereof at a regular meeting. In case of an approval, the application for a special permit shall be submitted within 180 days from the date of approval. Otherwise, the preliminary plan approval is null and void.

3. Energy Design Standards. Each planned solar residential development must meet the following design standards.
 - 3.1 For purposes of protecting solar access, streets, lots and building setbacks shall be designed so that at least 90 percent of the buildings in the project shall be oriented with their long axis running from east to west with a maximum possible deviation of 20 degrees north of due east (or 20 degrees south of due west) to 20 degrees south of due east (or 20 degrees north of due west).
 - 3.2 At least 90 percent of the dwelling units in all phases of the development shall be designed to make use of solar space heating and solar domestic hot water systems as the primary means of heating indoor habitable space and domestic hot water.
 - 3.3 Solar access must be unobstructed throughout the entire year for each building and dwelling unit utilizing its own solar energy system for space heating or for domestic hot water. The critical period for evaluating solar access shall be December 21st between 9 a.m. and 3 p.m.
 - 3.4 All planted vegetation shall be located so as not to interfere with solar access to any solar collector now or in the future.
 - 3.5 All dwelling units planned for solar space heating shall include double glazed south facing window walls with an effective surface area equal to at least 15 percent of the floor area of the dwelling unit.
 - 3.6 Standards for insulation in passive solar designed dwellings shall be at least twice the minimum specified by the Connecticut Basic Building Code, for floors, walls, and ceilings.
 - 3.7 The deed for each building must include solar skyspace easements to be approved by the Planning and Zoning Commission prior to the approval of the proposed project.
 - 3.8 Solar skyspace easements must include the following provisions:
 - 3.8.1 the solar altitude and solar azimuth on December 21st;
 - 3.8.2 restrictions on the height of vegetation, buildings, and other objects which would obstruct the passage of sunlight through the easement;
 - 3.8.3 the terms and conditions, if any, under which an easement may be revised or terminated.
4. Density Standards. The following standards shall determine the allowable densities for planned solar residential developments.

- 4.1 The maximum density of the entire tract will be 8 dwelling units per acre.
- 4.2 The maximum number of dwelling units contained within one multi family structure must not exceed 25 and the size of the individual dwelling units contained within one structure shall not exceed an average of 875 square feet per unit for each building.
- 4.3 No building shall exceed a length of 200 feet and no exterior wall of any building shall exceed 50 feet in length, in an unbroken plane, without an offset of at least 10 feet.
- 4.4 Where necessary, open space shall be provided as a buffer to adjoining residential, commercial and industrial properties to the south to avoid the potential of obstructed solar access by vegetation, buildings or objects off the tract.
- 4.5 When a detached community solar energy system is contemplated, open space shall be dedicated to the south of the collector to ensure future solar access.
5. Dimensional Standards. The following dimensional standards supersede the standards set forth in the zoning regulations for the underlying zoning district.
 - 5.1 No building shall extend within less than 150 feet of any street line or other property line.
 - 5.2 No tract shall have less than 75 feet of frontage at the point where the main entrance intersects with the public highway.
 - 5.3 Maximum height of a structure may be up to 65 feet as long as the shadow projection cast by the structure on December 21st between the hours of 9 a.m. and 3 p.m. does not obstruct solar access for any structure on or off the tract.
6. Parking. Parking shall be provided in accordance with the requirements of the zoning regulation. However, no open parking shall extend to within less than 20 feet of any dwelling.
7. Utilities. All utilities shall be placed underground.
8. Open Space. All land not utilized for dwellings and private usable outdoor space shall be considered common land. Such land shall be in such condition, size and shape as to be readily usable for circulation, parking, recreation, community gardening, wood energy management or for the siting of community renewable energy systems.
9. Landscaping. It is the intent of the commission to encourage the developer to preserve the natural vegetation of the site and to make use of it for passive or natural heating and cooling opportunities in the design and orientation of structures wherever practical. Therefore, existing vegetation (generalized) shall be shown on the preliminary plan along with proposed construction with an indication of general areas to be disturbed. The developer shall stabilize and landscape disturbed areas, to prevent erosion and shall plant evergreen shrubs approved by the commission on northern exposures of dwelling foundations, wherever possible.

10. Preliminary Plan of Development. A preliminary plan of development should be submitted to the planning and zoning commission to show the intent and arrangement of the proposed uses to be included in the development as well as to present the applicant's case for the need of the proposed development in the town of Avon along with the applicant's qualifications to assure the successful completion of such a development which is substantially relying on solar energy for space heating and domestic hot water.

The following shall be required as part of the preliminary plan of development.

- 10.1 The location of all dwelling units as proposed and their relationship to all abutting, proposed or existing units shall be shown. Each structure shall be shown by a square or rectangle which shall be realistic in size and have an orientation of its long axis deviating not more than 20 degrees south of due east or 20 degrees north of due east. Any construction on any lot shown shall not extend beyond the area included in the square or rectangle or be oriented beyond the permissible deviations from due east specified for the long axis of the structure.
- 10.2 A tabulation of proposed buildings by type, size (number of bedrooms, floor area), ground coverage and a summary table showing the percentage of the tract to be occupied by buildings, parking and other paved vehicular areas, sidewalks and walkways and the usable open space as well as an overall map showing the same at a scale no smaller than 1" = 100' with an accompanying A-2 survey map of the entire tract.
- 10.3 A general description of the advantages of the tract for solar energy and the degree of solar access protection afforded at the site.
- 10.4 The proximity of the proposed development to public transportation, recreation facilities, neighborhood shopping and service facilities.
- 10.5 An estimation submitted by a certified engineer of the expected level of energy to be contributed by solar energy to the space heating and domestic hot water heating requirements of each dwelling unit in the development based on heat gain and heat loss calculations as specified in Article MCA-14 of the Connecticut Basic Building Code.
- 10.6 A general description of the tract in question and surrounding areas, describing the degree of compatibility of proposed use with the existing neighborhood.
11. Supplementary Map Standards. In addition to the requirements for site plan approval contained in the zoning regulations, the following map requirements for planned solar residential development shall be met.
- 11.1 The location, size and type of all existing and proposed vegetation shall be shown and their shadow patterns delineated based on the shadow length table and calculation procedures shown in Appendix 3.
- 11.2 Accurately delineate the location and orientation of all detached solar collectors and building lines with respect to shadows cast by trees, buildings and other objects. Exact orientations to true south will be shown and shall be correct to within one degree. The shadow pattern and building orientation map shall be drawn to a scale not smaller than 100 feet to the inch.

12. Approval Criteria. The following is a list of criteria which will be used, in addition to the design criteria and other requirements of this section of the regulations, to determine whether all the requirements have been met and the development meets the full intent of the planned solar residential development concept.
- 12.1 Development has been concentrated in those areas with the best solar access.
- 12.2 Existing vegetation has been preserved and where possible utilized for summer shading and winter windbreaks.
- 12.3 The proportion of space heating and domestic hot water is substantial (50 percent or greater) for at least 90 percent of the dwellings in the development.
- 12.4 Applicant has provided adequately for the private control of obstructions to solar access through deed restrictions and maintenance procedures.
- 12.5 The location of development will foster a stronger town center concept and be within walking distance of existing public transportation.
- 12.6 The location of buildings have been sited to maximize an owner's control or a homeowner association's control over shading.
- 12.7 Solar access is not and will not be affected by building and tree shadows originating off the tract.
- 12.8 Street orientations are supportive of properly oriented buildings.
- 12.9 Land with poor solar access and exposures to winter winds have been dedicated for open space wherever possible.
- 12.10 Open space and proposed use of open space is significant and beneficial.
- 12.11 The pedestrian circulation system is adequate.
- 12.12 Traffic and circulation patterns do not create undue increased traffic safety hazards.

Proposed Zoning Regulations

Intent. To encourage an energy efficient pattern of development, the use of energy conservation techniques in land use development and the use of solar and other renewable energy resources so that the Town may begin to reduce its dependence upon fossil based fuels, nuclear power and other non-renewable energy resources for space heating, domestic hot water and for the propulsion of vehicles.

Height. No structure shall exceed the maximum height as specified except that such regulations shall not apply to the following exempted structures:

- a. flagpoles no more than 50 feet in height;
- b. spires, belfries, and cupolas no more than 20 feet in height;
- c. water tanks and ventilators no more than 10 feet in height;
- d. elevator penthouses no more than 10 feet in height;
- e. farm silos, windmills, barns and water tanks provided that no such structure shall be more than 50 feet in height;
- f. chimneys no more than 50 feet in height in industrial zones and all other chimneys extending no more than 3 feet above the highest point of the roof opening of such chimney;
- g. solar energy collection equipment, solar energy reflectors, or solar energy storage tanks extending no more than 5 feet above the highest point of the roof;
- h. other appurtenances usually required to be above the roof level and not intended for human occupancy provided such structures are incidental to a permitted use located on the same property.

Coverage. The aggregate lot coverage of all structures on any lot shall not exceed the percentage of the lot area as specified. In computing lot coverage, no solar collection device, solar reflector or similar device shall be considered unless the solar collector or related device is incorporated into the floor area of the building.

Projections. Belt courses, cornices, marquees, pilasters, and similar architectural features may project up to three feet into the area required for setback from a street or other line. Architectural features needed for the operation of active or passive solar energy systems, including but not limited to canopies, eaves, overhangs, detached solar collectors, reflectors, and movable insulation may be permitted to extend up to 5 feet into the required yard area when these devices are a functional component of the space heating or domestic hot water system of the principal building on the lot.

Fences. Fences shall not be over 8 feet in height anywhere on the property and must not cast a shadow which would obstruct the efficient operation of a solar energy system meeting the minimum front yard or rear yard setback requirements for the zone in which it is located.

Permitted Uses. Solar energy systems either as part of a structure or as an independent structure providing a significant fraction of the space heating, space cooling or domestic hot water heating for a permitted use in any zone subject to the following conditions:

1. No solar energy system located on the ground shall exceed a height of 8 feet;
2. glare or reflection from solar energy systems located on the ground or on the rooftop shall not interfere with highway safety;
3. the maximum ground coverage of a structure supporting a solar collector located in a front yard shall not exceed 25 percent of the area of the ground floor of the principal building.

Enlargement of a Nonconformity: No nonconforming use of land shall be enlarged, extended or altered and no building or other structure or part thereof devoted to a nonconforming use shall be enlarged, extended, reconstructed or structurally altered, except where the result of such changes is to reduce or eliminate the nonconformity. Nothing in this section shall be deemed to prohibit the installation of a solar energy system on a nonconforming building or structure as long as the solar energy system does not increase the nonconformity.

Variances of Dimensional Requirements: Under no conditions may the Zoning Board of Appeals grant a variance to the dimensional requirements of these regulations when this would result in the erection, extension, enlargement or alteration of a building which would cast a shadow onto an existing solar energy system on December 21st during the hours from 9 a.m. to 3 p.m.

Furthermore, where granting a variance will not affect solar access to an existing solar energy system, the dimensional requirements of these regulations including lot frontage, building height, setbacks from front, side or rear yards, fence heights, minimum lot width and maximum lot coverage shall not be varied by more than 15 percent over the requirements specified for each zone.

Maximum height of structure: Maximum building height shall be 40 feet except as specified herein for the protection of solar skyspace to adjoining dwelling units. No building or structure shall cast a shadow on the south facing wall of any dwelling measured at the first floor between the hours of 10 a.m. and 2 p.m. on December 21st standard time. However, this ordinance shall not apply to any building or structure which already casts a shadow upon a south wall at the time of the adoption of this regulation.

Fences: Fences shall not be over 6 feet in height anywhere on the property and must not cast a shadow which would obstruct the efficient operation of a solar energy system meeting the minimum front yard or rear yard setback requirements for the zone in which it is located.

Permitted Uses: Solar energy systems either as part of a structure or as an independent structure providing a significant fraction of the space heating, space cooling or domestic hot water heating for a permitted use in any zone subject to the following conditions:

Definitions

- Building: Any structure having a roof and intended for the shelter, housing or enclosure of persons, animals or materials. Solar energy collection systems mounted on the ground shall not be considered buildings.
- Floor Area: For purposes of meeting minimum habitable floor area requirements, those parts of a building which are part of the heated interior, with a minimum headroom of seven feet (floor to ceiling vertically). Rooms partially or completely below grade may be counted only if there is window area equal to 1/10 or more of the floor space in each room and adequate provisions are made for exit in case of fire or other emergency. Enclosed porches, attached greenhouses and other attached structures may be counted only when they utilize passive solar heating and are constructed with double glazed windows covering an area equal to at least 10 percent of the floor area of the space enclosed by the walls of the building.
- Lot Coverage: The ground area enclosed by the walls of a building together with the areas of all covered porches and other roofed buildings but not including solar energy collection systems mounted on the ground.
- Planned Solar Residential Development: A residential development designed to make optimum use of solar energy for domestic hot water and space heating and which is located on a tract of land with suitable solar access and at densities which are consistent with the provisions of energy efficient patterns of development.
- Solar Collector: Any device, absorbent surface, structure or window (double glazing or greater) which is oriented in such a fashion that it can be utilized for the collection of solar energy to supply a significant fraction of the energy needed for space heating or for domestic hot water.
- Solar Energy System: Any system, design, assembly or device which is used to collect, store, and distribute energy derived from the sun for the purpose of heating or cooling the interior spaces of buildings or for heating domestic hot water. Solar energy systems may include but are not limited to solar collectors, solar reflectors, heat storage tanks, south facing double glazed window walls, attached south facing greenhouses utilizing double glazing, and architectural overhangs for blocking sunlight on south facing windows.
- Solar Skyspace: The space between a solar energy collector and the sun which must be free of significant obstructions to ensure the cost effective operation of the system between the hours of 9 a.m. and 3 p.m. on June 21st and December 21st of each year.

Definitions (continued)

Solar Skyspace

Eastment:

A Right, expressed as an easement, covenant, condition, or other property interest in any deed or other instrument executed by or on behalf of any landowner, which protects the solar skyspace of an actual, proposed, or designated solar energy collector at a described location by forbidding or limiting activities or land uses that interfere with access to solar energy. The solar skyspace must be described as the three-dimensional space in which obstruction is prohibited or limited, as well as the times of day during which direct sunlight to the solar energy collector may not be obstructed.

South:

The orientation of any building or structure shall be considered as facing south if its longest axis has a maximum deviation of 20 degrees north of due east to 20 degrees south of due east.

Not Covered:

The ground area enclosed by the walls of a building together with the area of all covered porches and other roofed buildings but not including solar energy collection systems mounted on the ground.

Planned Solar Residential Development:

A residential development designed to make optimum use of solar energy for domestic hot water and space heating and which is located on a tract of land with suitable solar access and at densities which are consistent with the provisions of energy efficient patterns of development.

Solar Collector:

Any device, absorbent surface, structure or window (double glazing or greater) which is oriented in such a fashion that it can be utilized for the collection of solar energy to supply a significant fraction of the energy needed for space heating or for domestic hot water.

Solar Energy System:

Any system, design, assembly or device which is used to collect, store, and distribute energy derived from the sun for the purpose of heating or cooling the interior spaces of buildings or for heating domestic hot water. Solar energy systems may include but are not limited to solar collectors, solar reflectors, heat storage tanks, south facing double glazed window walls, attached south facing greenhouses utilizing double glazing, and architectured overhangs for blocking sunlight on south facing windows.

Solar Skyspace:

The space between a solar energy collector and the sun which must be free of significant obstructions to ensure the most effective operation of the system between the hours of 9 a.m. and 3 p.m. on June 21st and December 21st of each year.

SKYSPACE AND SHADOW DATA

Determining the Shadow Pattern for a Building or Tree

The shadow pattern for a building or tree can be determined in much the same way used to determine the pattern for a single pole. A building or tree can be treated as a number of poles as pictured in Figures 1 and 2.

Although trees are not shown in this example, the planner should realize that trees have depth, as buildings do. For maximum accuracy, additional poles located to the north of the tree crown "centerline" might also be considered. Trees with various common shapes also can be represented by poles of varying heights (Figure 2).

The shadow lengths for each pole at the critical times of day are laid out, and the composite of all shadows for all poles yields the pattern for the building or tree. The following example shows how this is done for a building and tree simultaneously:

Building is 9' high at eaves and 12' high at peak.

Tree is 40' high and 30' wide.

Latitude of location is 41° 30' north.

Land slopes to southwest at 15 percent grade.

Step 1. Draw an overhead plan of the building and tree using a series of poles (Figure 3).

Step 2. From table A find the shadow length values for a.m. and noon. They are:

a.m. - 5.5

noon - 1.9

p.m. - 3.0

Multiply the ratios times the height of the poles used in the building and tree examples.

Shadow Length Table for 9', 12', and 40' Poles 41° 30' N. Latitude				
	Height of Pole	Shadow Length		
		A.M.	Noon	P.M.
Building	9'	50	17	27
	12'	66	23	36
Tree	40'	220	76	120

Step 3. Scale the shadow lengths out on the overhead views of the buildings and trees. The boundaries of the skyspace in this case are 45 degrees and so the a.m. and p.m. shadow lengths are laid out at 45 degrees east and west of north. (See Figure 4.)

Step 4. Connect the end points of the shadow lines. The resulting figures approximate the area of ground shaded by the building and tree between the hours of the morning and afternoon that correspond to the 45 degree azimuths (Figure 5).

Figure 1: Representing a Building or Trees as a Set of Poles

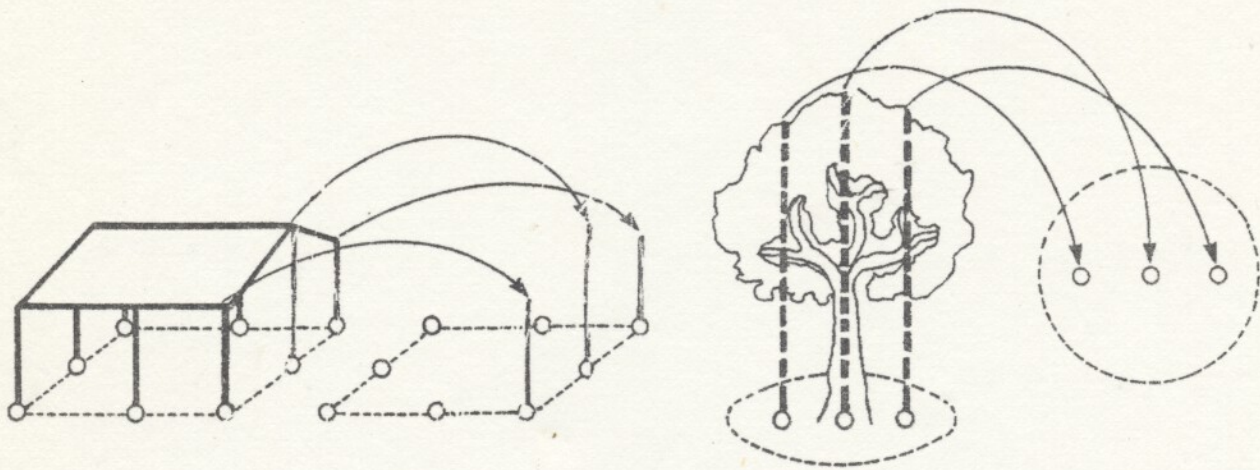


Figure 2: Representing Various Tree Crown Types as Sets of Poles

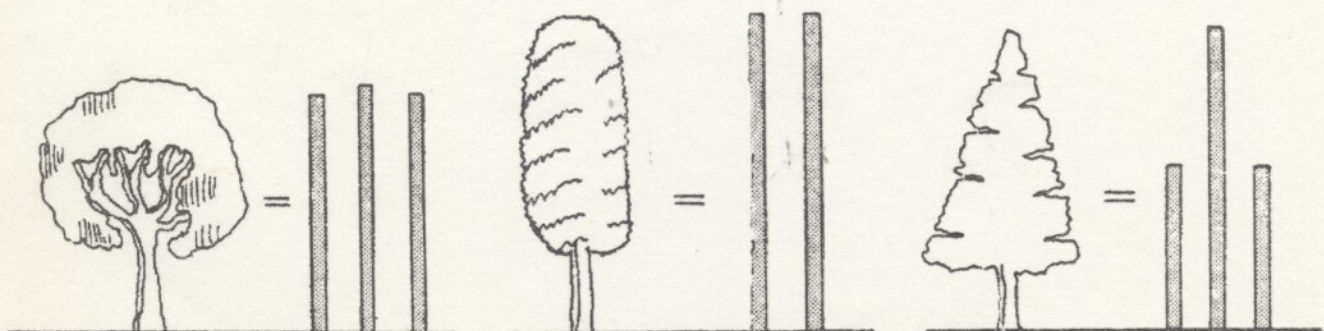


Figure 3: Overhead Plan

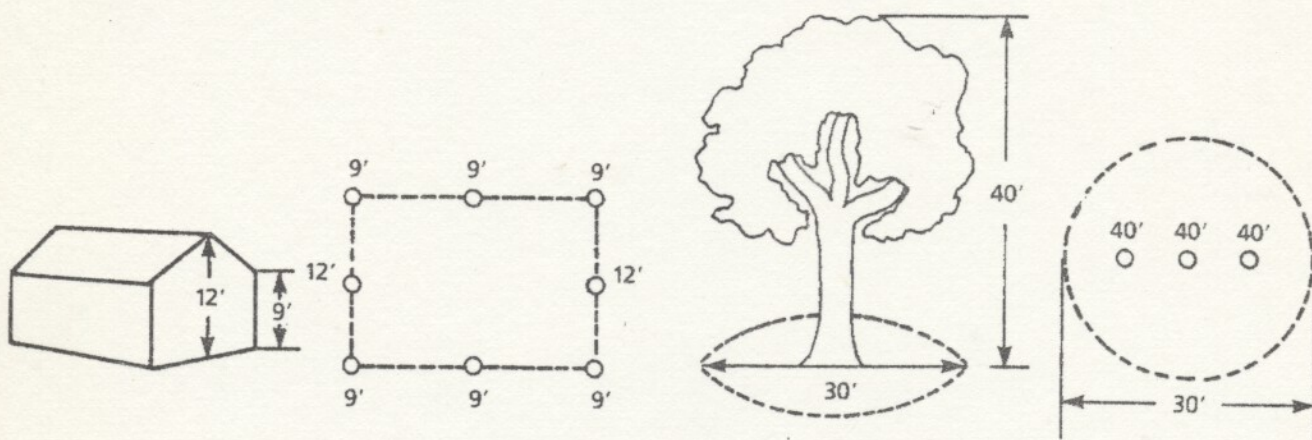


Figure 4: Shadow Lines

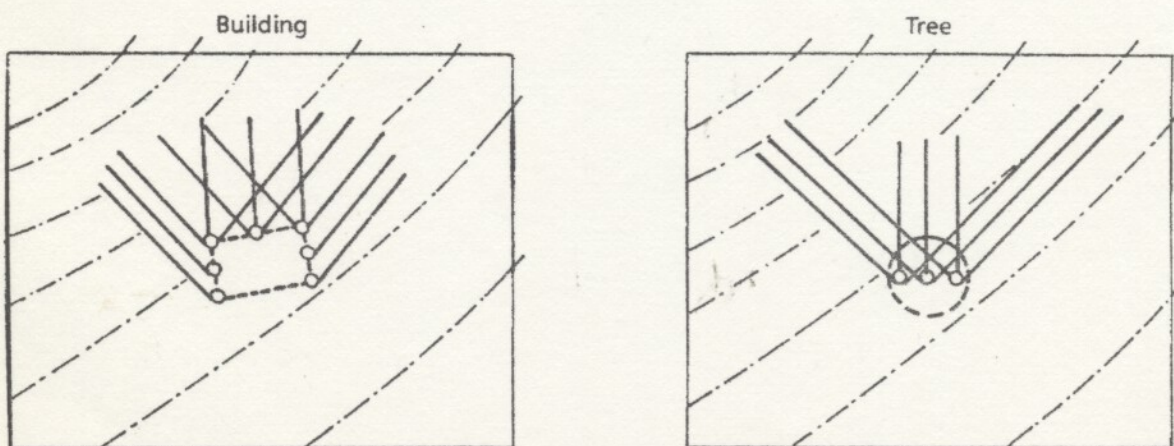


Figure 5: Shadow Patterns

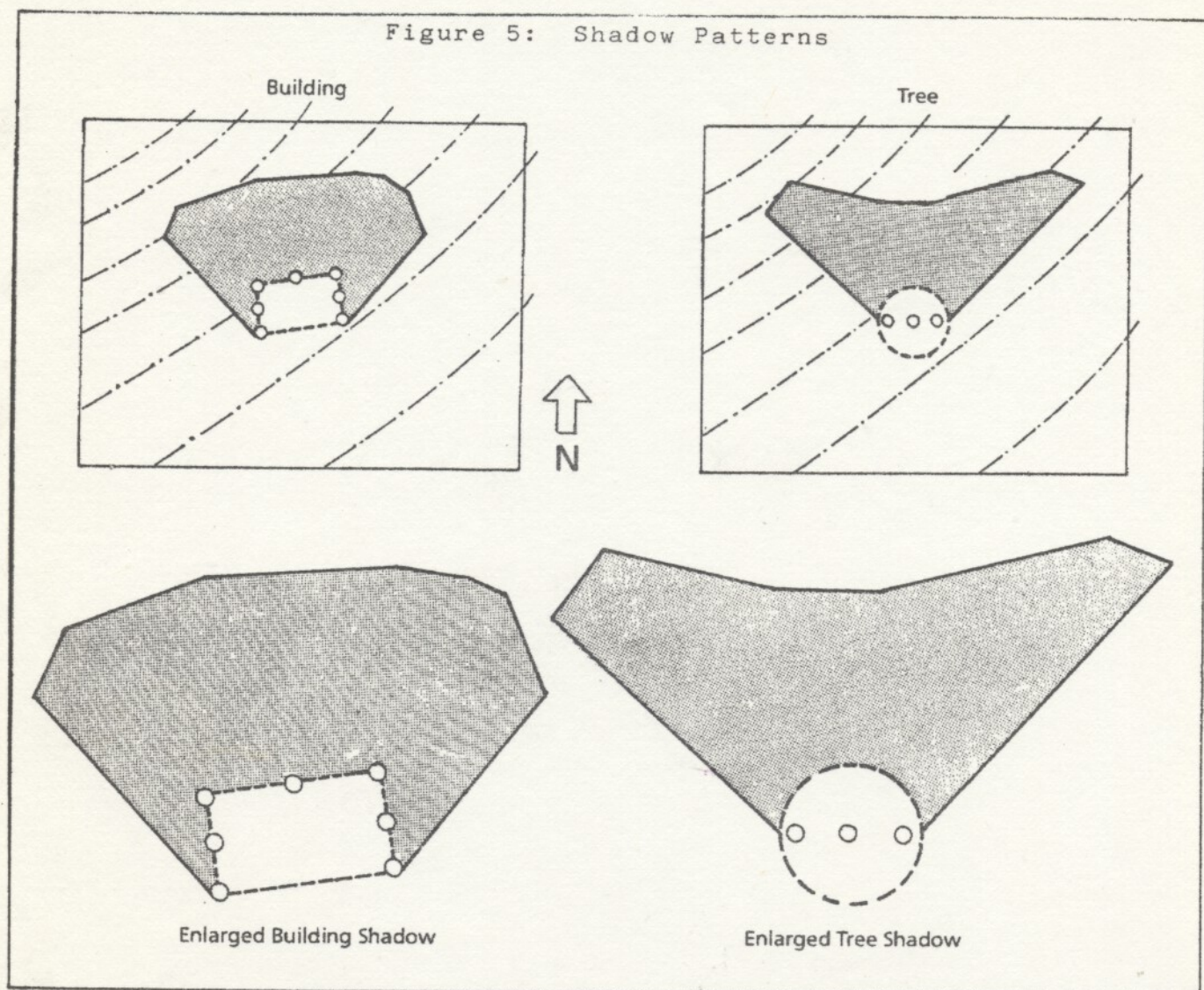


TABLE A: Shadow Length Table for the Central Naugatuck Valley Region

Latitude 41° 30'

Slope	N		NE		E		SE		S		SW		W		NW	
	A.M.	NOON P.M.	A.M.	NOON P.M.	A.M.	NOON P.M.	A.M.	NOON P.M.	A.M.	NOON P.M.	A.M.	NOON P.M.	A.M.	NOON P.M.	A.M.	NOON P.M.
0%	5.5	2.2	5.5	2.2	5.5	2.2	5.5	2.2	5.5	2.2	5.5	2.2	5.5	2.2	5.5	2.2
5%	6.8	2.4	6.8	2.4	7.5	2.4	7.5	2.4	7.5	2.4	7.5	2.4	7.5	2.4	7.5	2.4
10%	9.4	2.8	9.4	2.5	14.1	2.5	14.1	2.5	14.1	2.5	14.1	2.5	14.1	2.5	14.1	2.5
15%	15.8	3.3	15.8	5.5	2.9	-	3.5	2.2	15.8	3.0	1.9	5.5	3.5	1.7	3.0	15.8

Source: CTVRIA staff work based upon Appendix I of Protecting Solar Access for Residential Development:
A Guidebook for Planning Officials, American Planning Association, 1979.

Appendix 4: Distribution of Land in Cheshire
and Woodbury by Orientation (in acres)

Orientation	<u>Cheshire</u> Acres	Percent	<u>Woodbury</u> Acres	Percent
North	740	3.4	859	3.7
Northeast	1,154	5.5	1,587	6.8
East	3,798	17.9	4,238	18.1
Southeast	1,202	5.7	1,546	6.6
South	1,244	5.9	1,704	7.3
Southwest	855	4.0	2,047	8.7
West	1,863	8.8	4,594	19.6
Northwest	1,186	5.6	821	3.5
No Orientation (Flatland)	9,146	43.2	6,024	25.7
Total	21,188	100.0	23,420	100.0

Source: CNVRPA staff work based on calculations of municipal land areas by orientation of slopes from U.S. Geological Survey Maps, December 1979.

FOOTNOTES

¹In simple terms the Trombe wall (named after Professor Felix Trombe) collects solar energy by using the wall of the building as a heat storage device. The Trombe wall is typically a concrete wall inside a south facing glass window which absorbs and stores solar energy. During periods of the day when solar radiation is not available the Trombe wall releases its stored heat into the room. The greater the mass of the heat storage device the greater its ability to serve as a passive solar furnace. The concept should be familiar to anyone who has sat down in the seat of a closed automobile after it has been sitting in the sun for some time. The Trombe wall, like automobile upholstery, can absorb considerable heat under direct sunlight.

²James M. Caborn, Shelter Belts and Windbreaks, Faber & Faber Ltd., 1965, p. 39.

³Euclidean zoning (after the landmark zoning case of Euclid vs. Ambler Realty) is a tool for segregating incompatible land uses by placing them in separate zones. For example, under Euclidean zoning residential development is generally not allowed in industrial zones and industrial development is not allowed in residential zones. Euclidean zoning has traditionally resulted in the imposition of uniform district-wide standards for all uses of a similar nature regardless of the potential differences associated with each specific development proposal. This inflexibility of Euclidean zoning has encouraged some Connecticut zoning commissions to seek greater control over individual development proposals through the use of the special permit or site development plan process.

⁴General Statutes of Connecticut, Section 7-147f.

⁵Roundtable conference with the Woodbury Historic Commission, Woodbury Town Hall, June 12, 1979.

⁶General Statutes of Connecticut, Section 22a-38.

⁷Interview with the Southbury Planning Administrator, May 1979.

⁸The Public Health Code of the State of Connecticut and Other Departmental Regulations, April 1978, Section 19-13-B20n, "Groundwater, Roof, Cellar and Yard Drainage."

⁹The Public Health Code of the State of Connecticut and Other Departmental Regulations, April 1978, Section 19-13-B51d, "Separating Distances."

¹⁰The State of Connecticut Basic Building Code governs all building construction in the 169 municipalities of the state. No construction, enlargement, alteration, or demolition can be undertaken without first filing an application for a building permit with the municipal building official. Solar energy systems are regulated by the general provisions of the Building Code and as of December 28, 1978 are also regulated by specific standards established for solar space heating, space cooling and domestic hot water equipment set forth in Article MCA-14. (See Appendix 1.)

¹¹During the months of May and June 1979, the CNVRPA staff conducted interviews with the building inspectors, town planners and installers of solar energy systems to determine the number of systems in the Region. The survey disclosed a total of 35 solar energy systems including two active solar space heating systems, one solar swimming pool heater and 32 solar domestic hot water systems.

¹²The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) has prepared a Handbook of Fundamentals which provides the approved methodology for determining the minimum size of the conventional back-up heating system. See Article MCA-1403.0 of the State of Connecticut Basic Building Code.

¹³See Section 113.5, Plans and Specifications and Section 113.7, Engineering Details of the State of Connecticut Basic Building Code for a description of the discretionary powers available to the local building official.

